

(12) **United States Patent**
Wagner

(10) **Patent No.:** **US 9,175,489 B1**
(45) **Date of Patent:** **Nov. 3, 2015**

(54) **WATER MANAGEMENT SYSTEM**

USPC 210/167.11, 167.12; 204/196.02, 225,
204/660, 661, 665, 666, 668
See application file for complete search history.

(71) Applicant: **Robin Wagner**, Glendale, AZ (US)

(72) Inventor: **Robin Wagner**, Glendale, AZ (US)

(73) Assignee: **Ronald James Turnbow**, Phoenix, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 251 days.

(21) Appl. No.: **13/848,451**

(22) Filed: **Mar. 21, 2013**

(56)

References Cited

U.S. PATENT DOCUMENTS

3,563,879 A *	2/1971	Richards et al.	210/167.11
3,926,802 A	12/1975	Hedgpeth	
3,948,632 A	4/1976	Ritchey	
4,098,602 A	7/1978	Seymour et al.	
4,282,104 A	8/1981	Pacini et al.	
5,332,511 A	7/1994	Gay et al.	
5,373,025 A	12/1994	Gay	
5,541,150 A	7/1996	Garris	
6,387,415 B1	5/2002	Garris	
6,824,794 B2	11/2004	Ring et al.	

FOREIGN PATENT DOCUMENTS

DE 10134403 A1 * 1/2003

* cited by examiner

Primary Examiner — Fred Prince

(74) *Attorney, Agent, or Firm* — Schmeiser, Olsen & Watts LLP

(57)

ABSTRACT

A water managing system includes a pool, and a gas generating system which includes first and second electrode assemblies. A reactant gas is formed in response to establishing a potential difference between the first and second electrode assemblies with automatically adjusting electrodes. A pool pump is in fluid communication with the pool, and a pool filter in fluid communication with the pool and pool pump. The reactant gas flows through a strainer drain of the pool pump and to the pool filter.

20 Claims, 32 Drawing Sheets

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/087,266, filed on Apr. 14, 2011, now abandoned.

(60) Provisional application No. 61/324,643, filed on Apr. 15, 2010.

(51) **Int. Cl.**

E04H 4/12 (2006.01)

C02F 1/46 (2006.01)

E04H 4/16 (2006.01)

C02F 1/461 (2006.01)

(52) **U.S. Cl.**

CPC **E04H 4/16** (2013.01); **C02F 1/46109** (2013.01); **E04H 4/1281** (2013.01)

(58) **Field of Classification Search**

CPC E04H 4/16; E04H 4/1281; C02F 1/46109

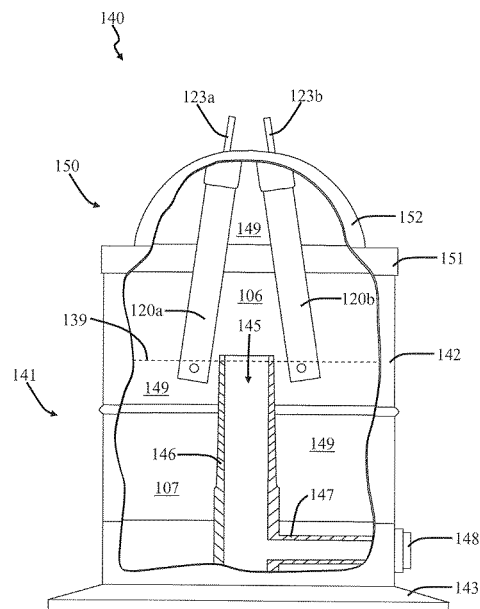


FIG. 1A

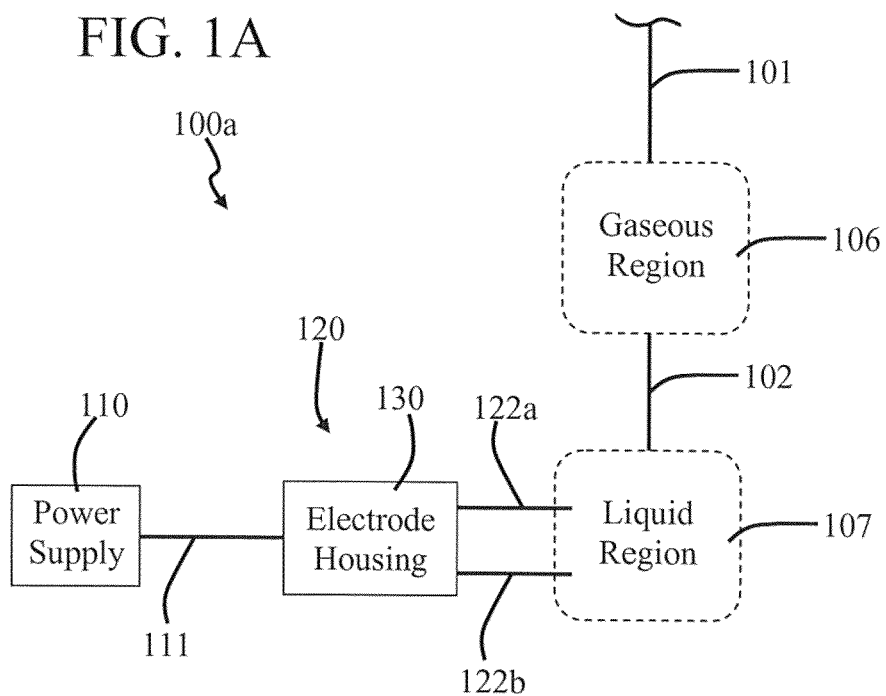


FIG. 1B

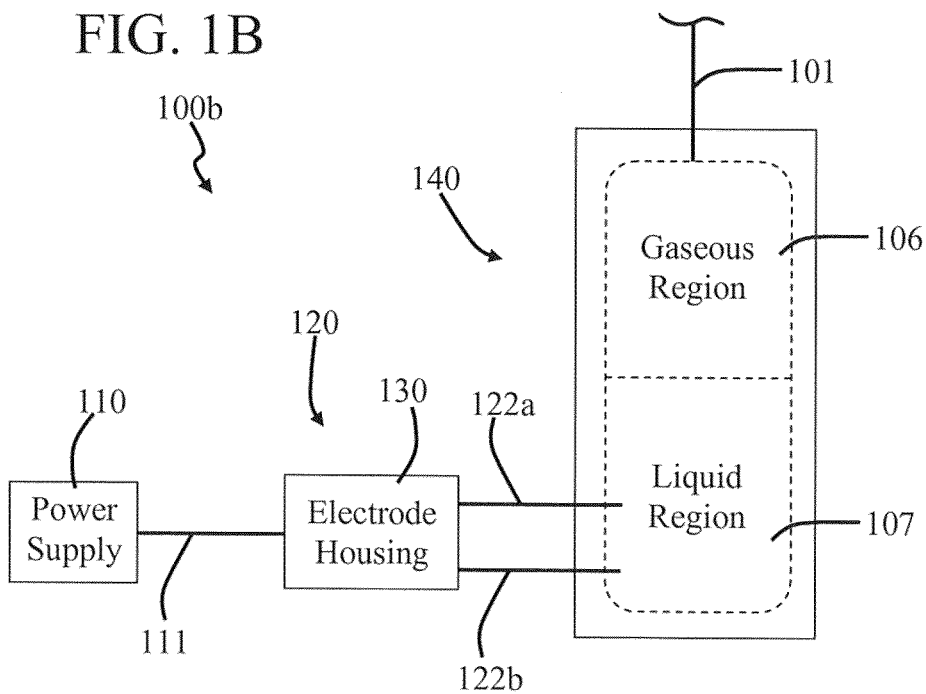


FIG. 1C

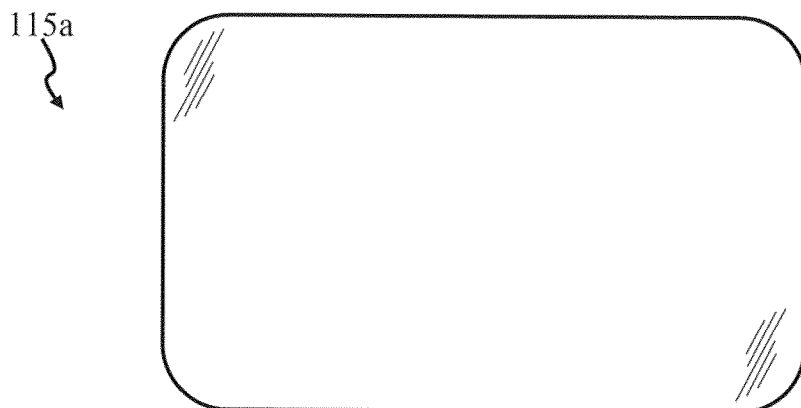


FIG. 1D

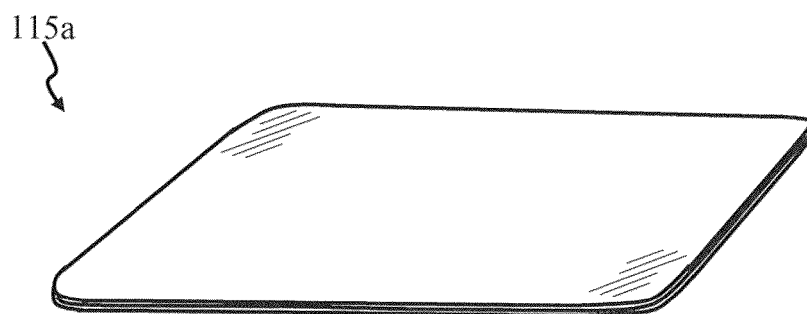


FIG. 1E

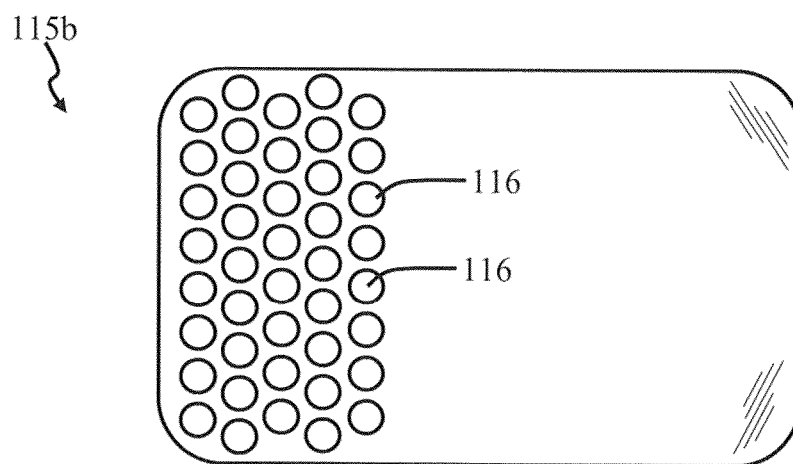


FIG. 2A

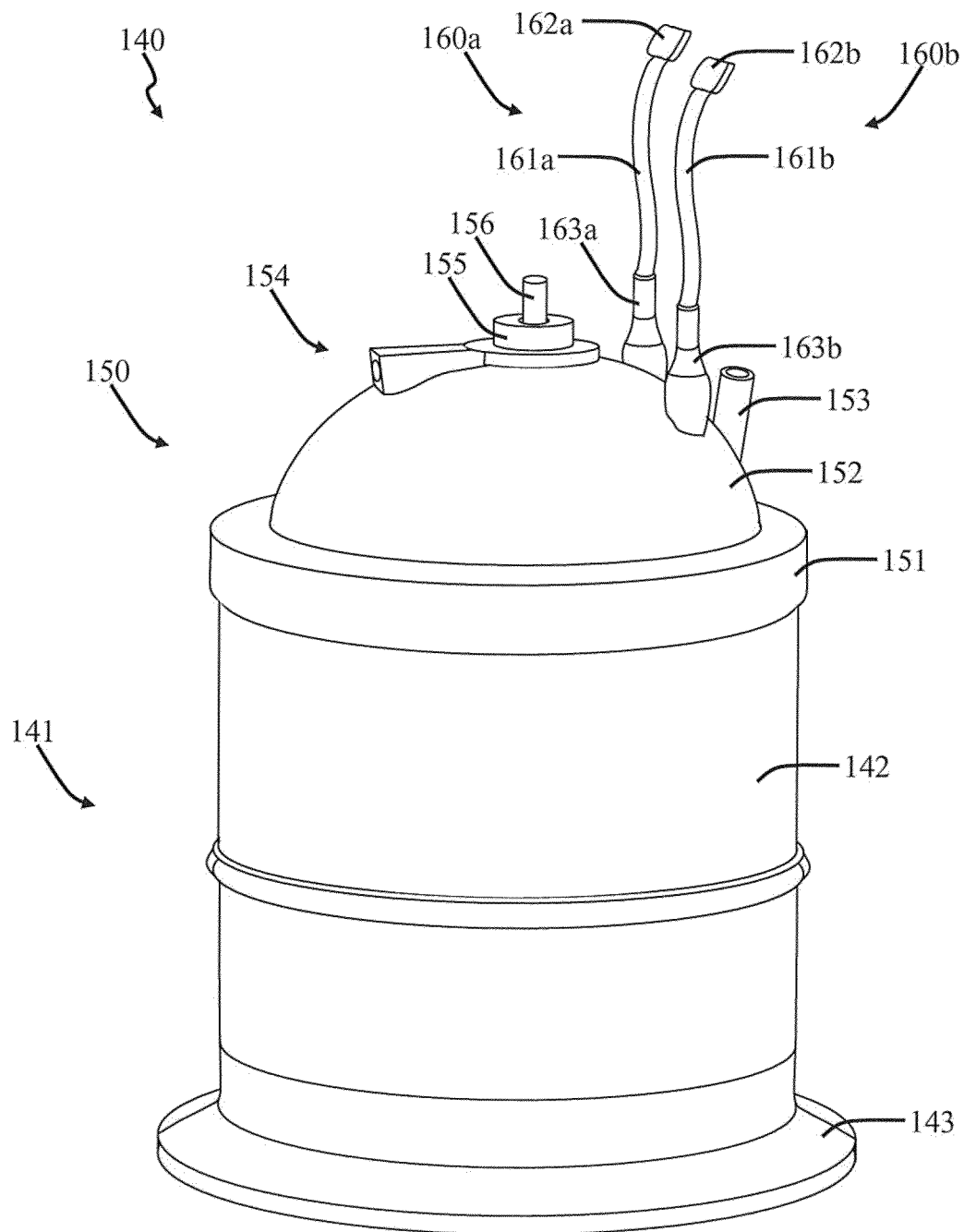


FIG. 2B

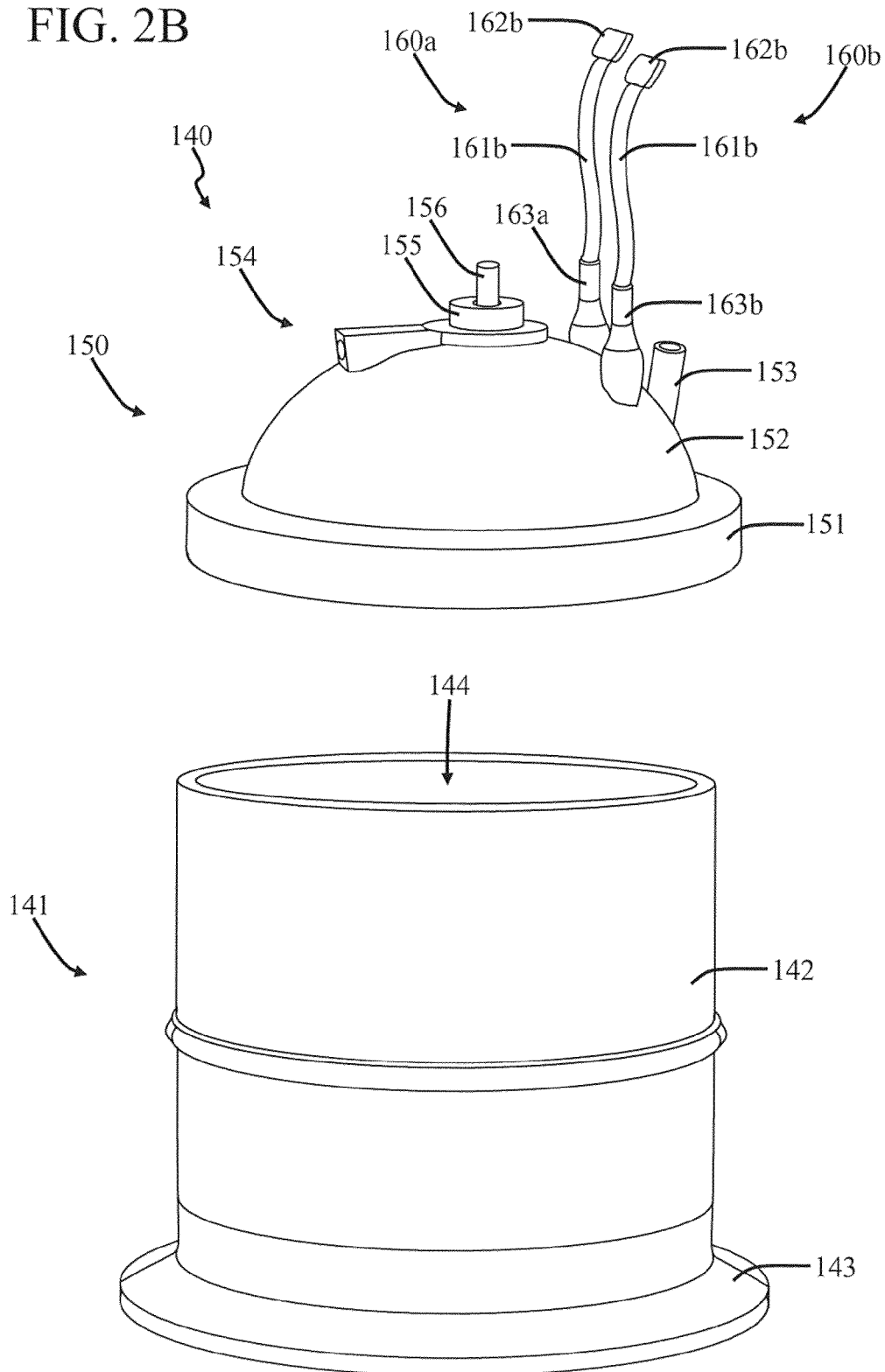


FIG. 2C

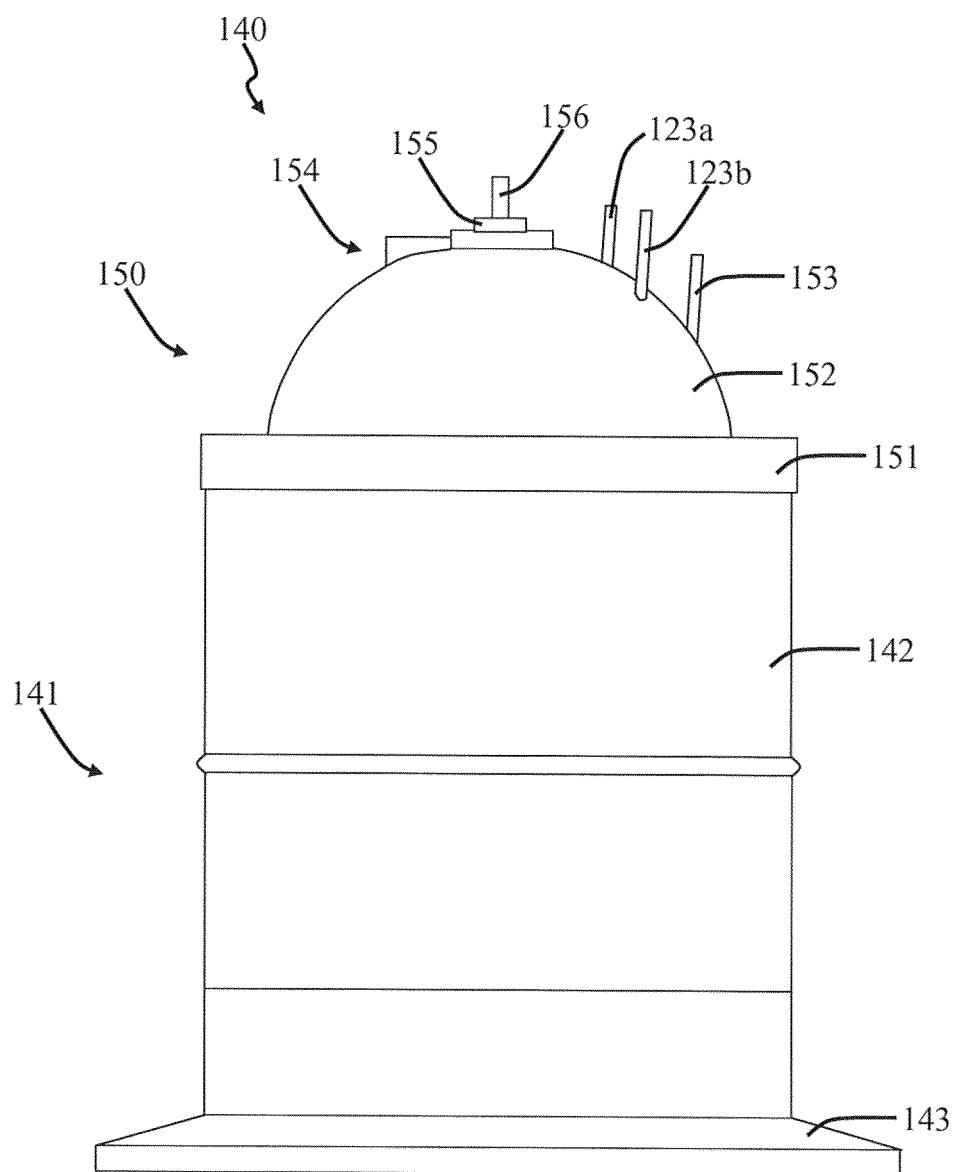


FIG. 2D

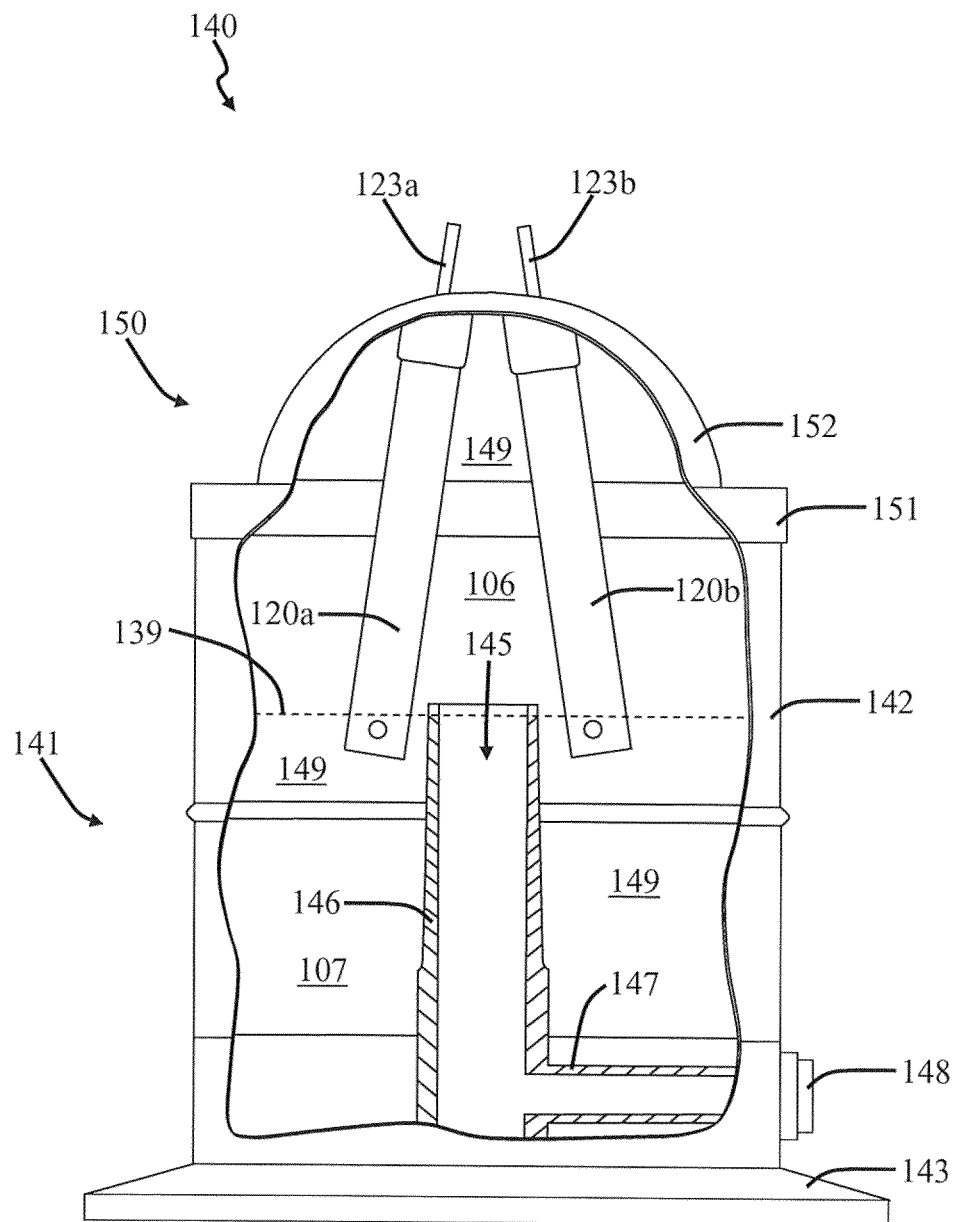


FIG. 3A

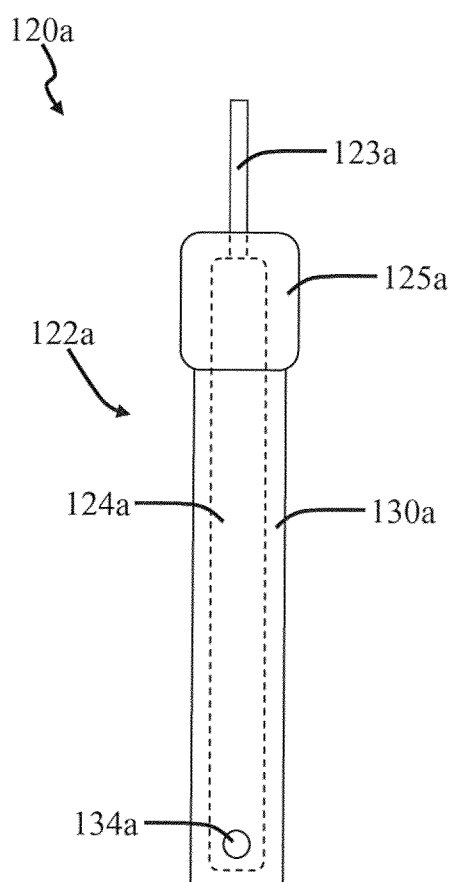


FIG. 3B

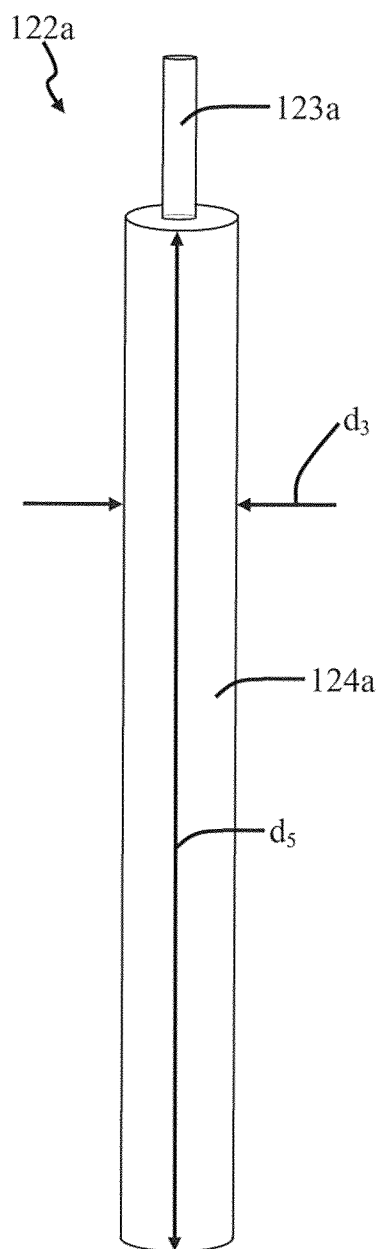


FIG. 3C

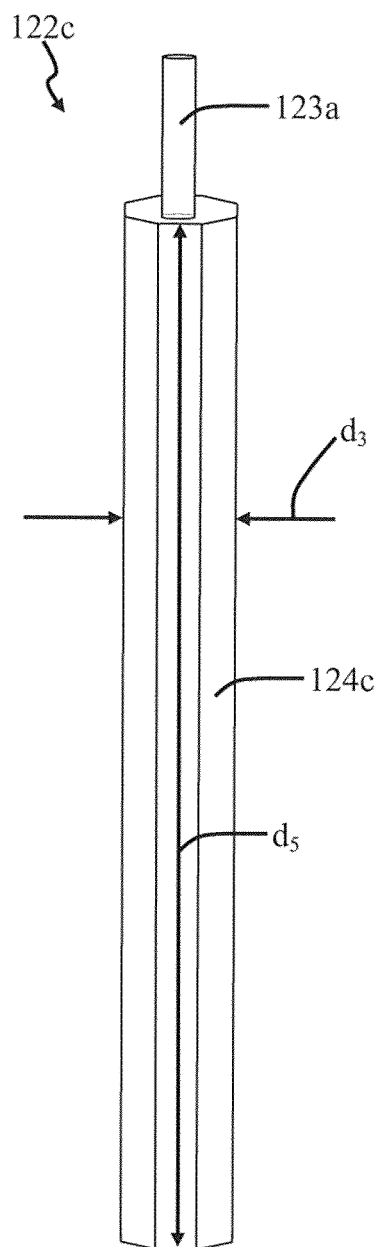


FIG. 3D

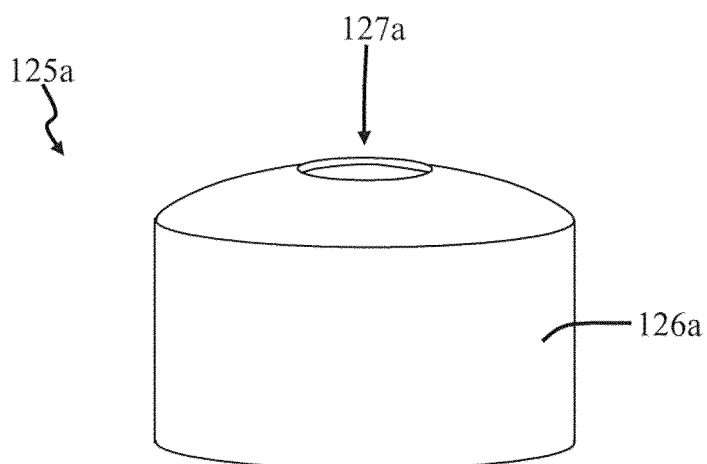


FIG. 3E

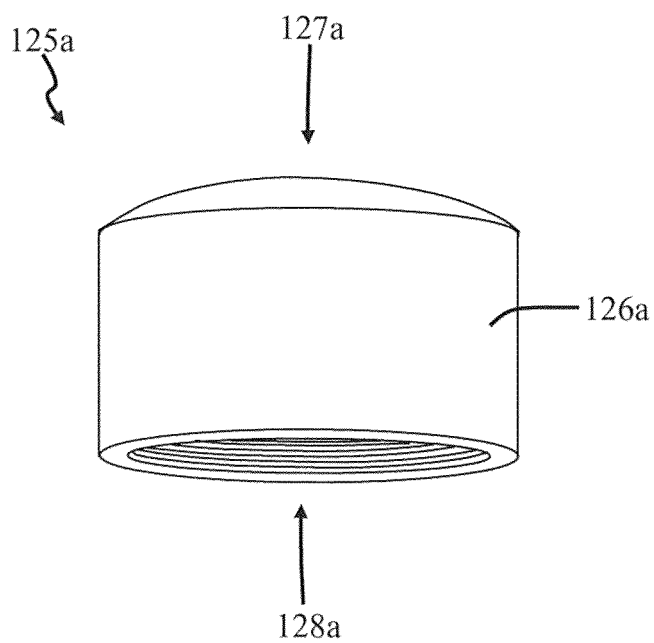


FIG. 3F

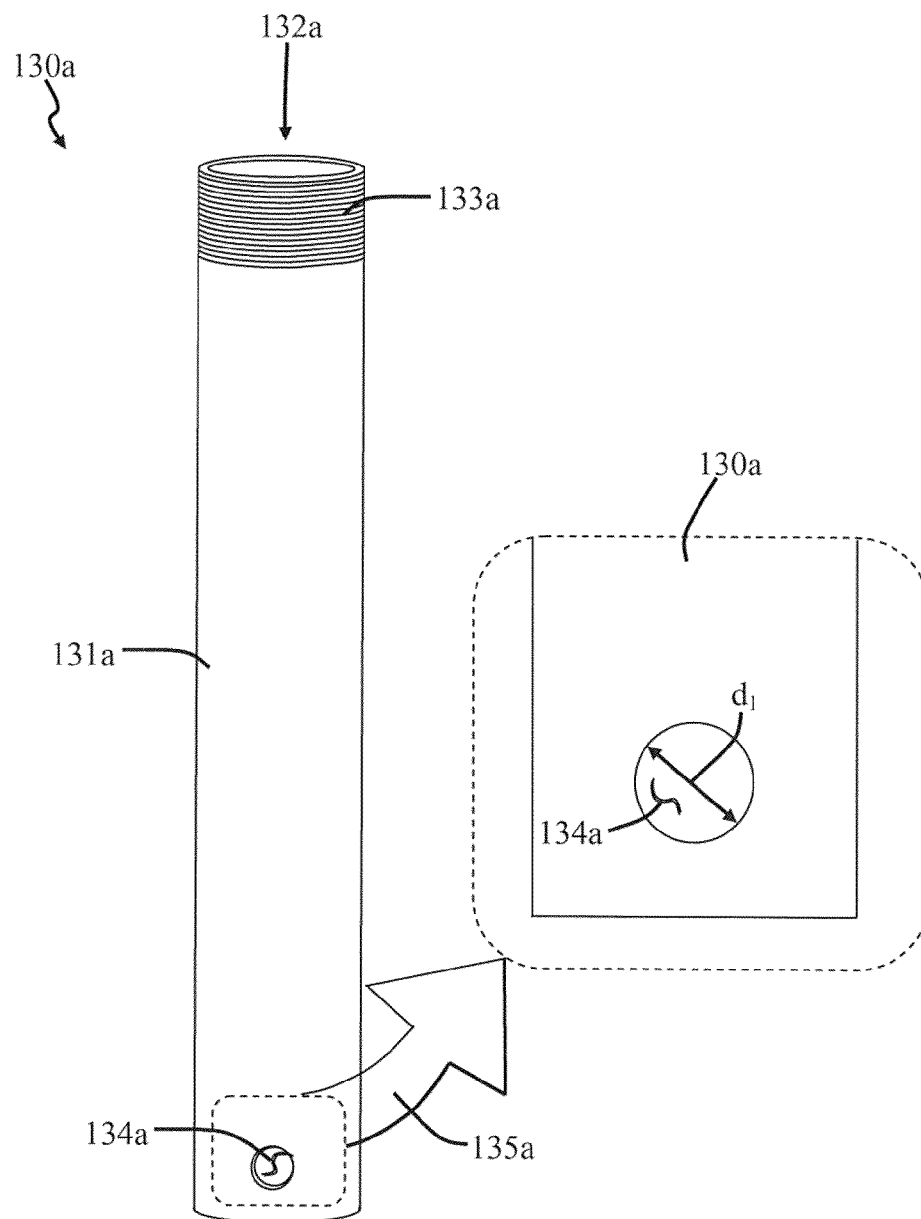


FIG. 4A

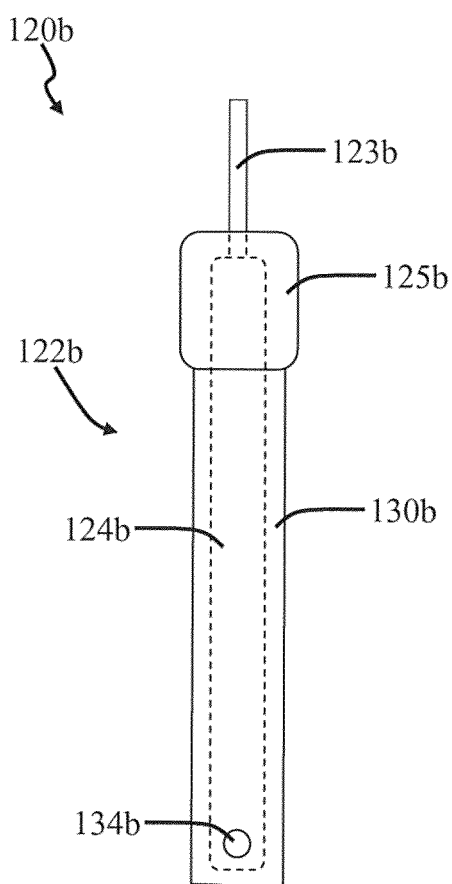


FIG. 4B

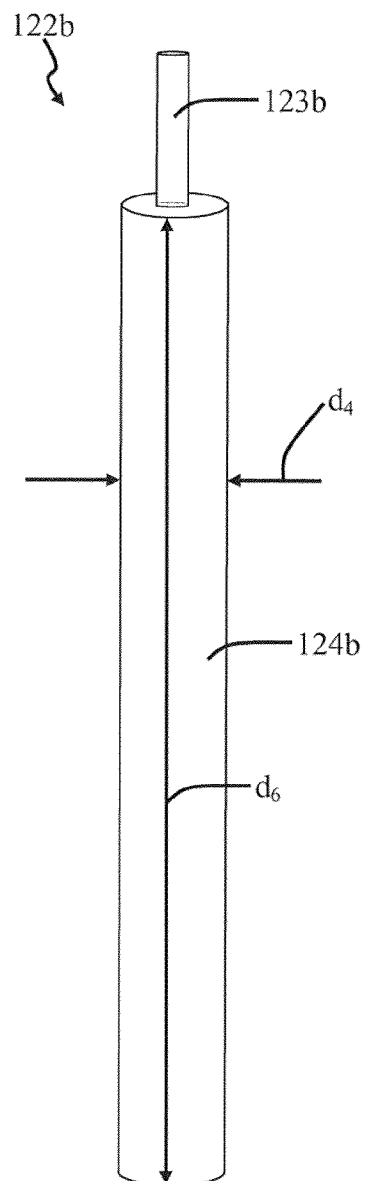


FIG. 4C

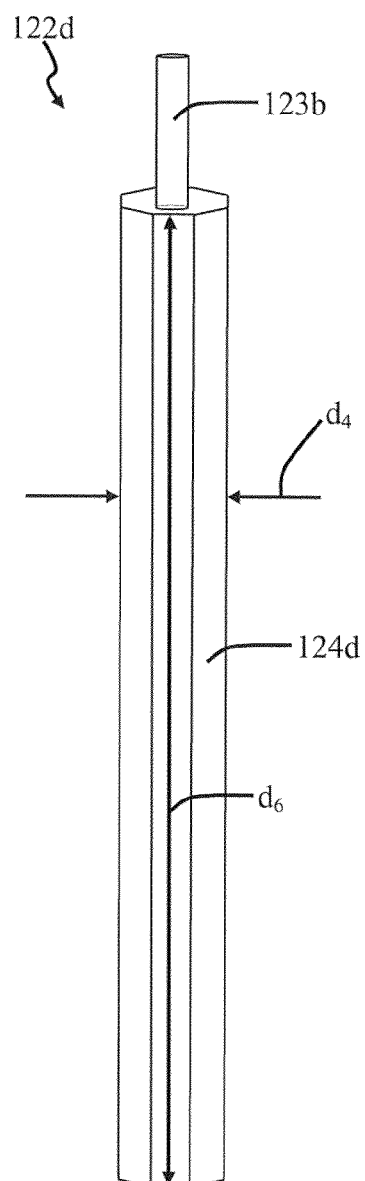


FIG. 4D

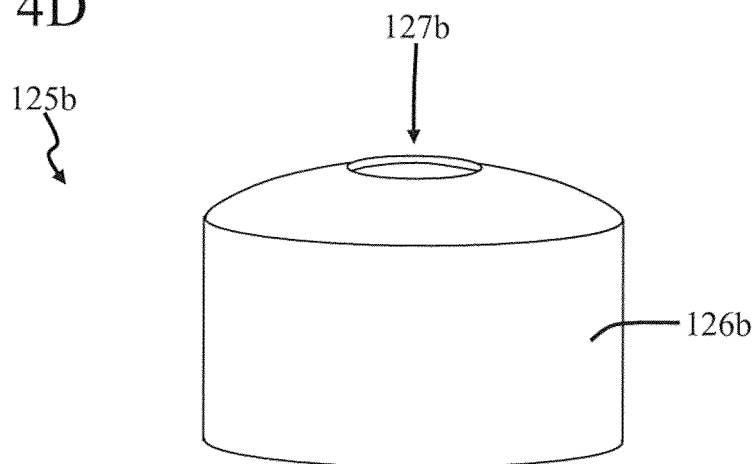


FIG. 4E

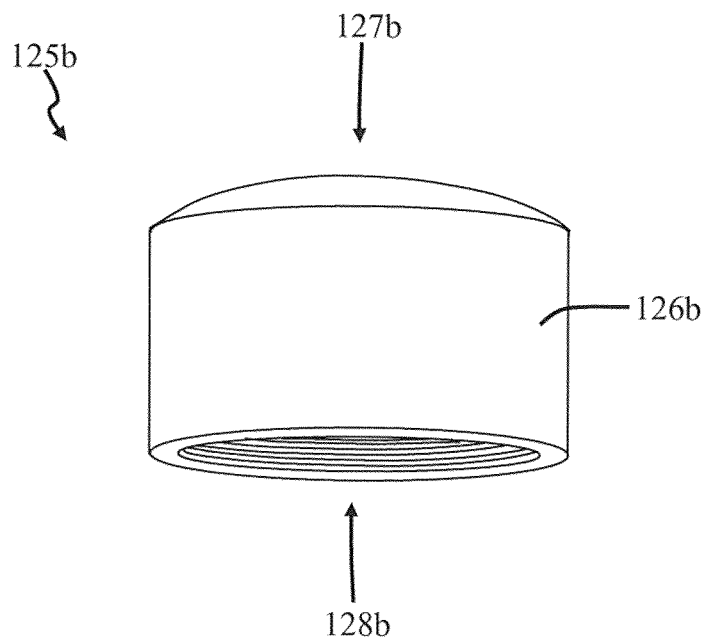


FIG. 4F

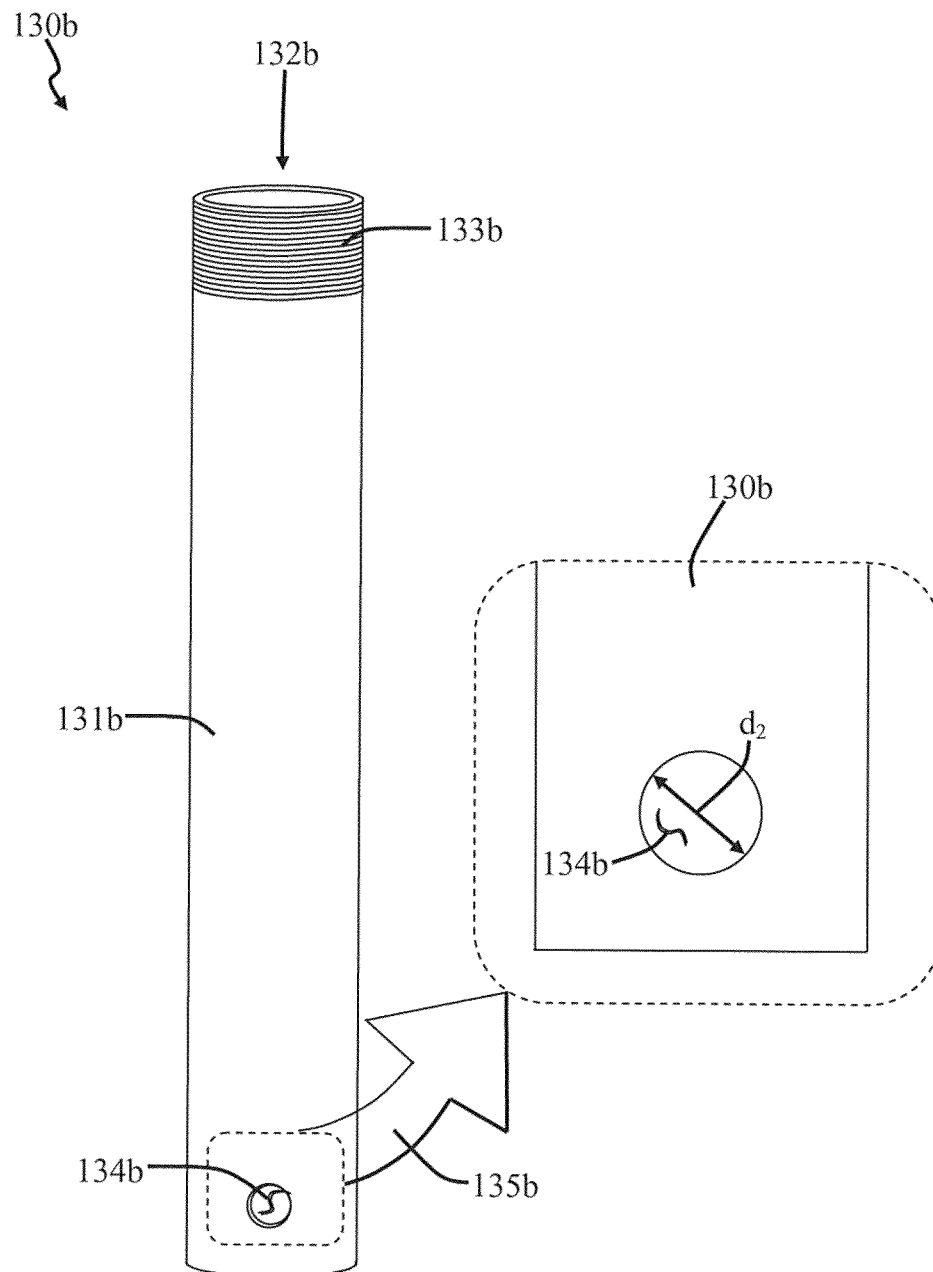
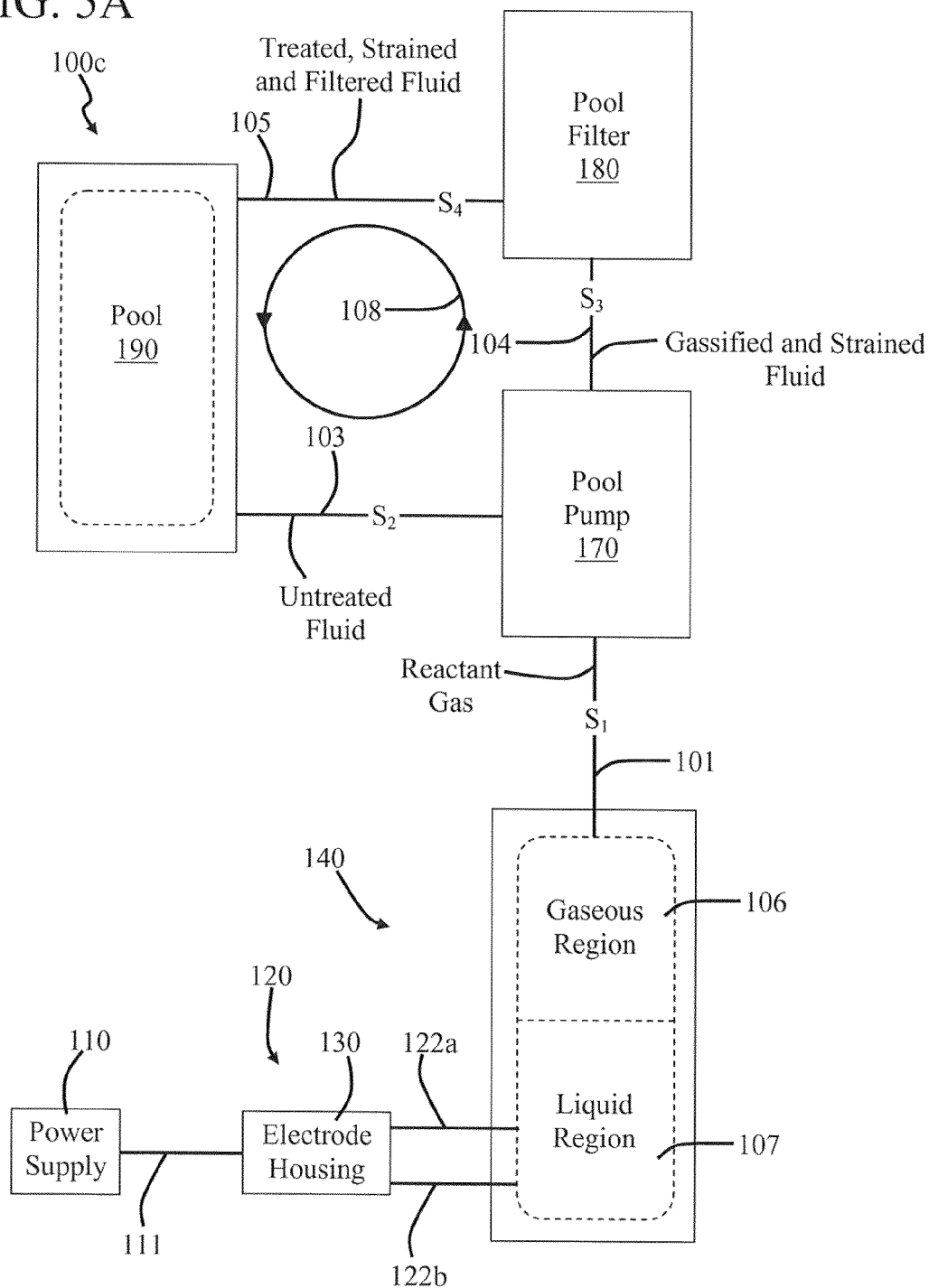


FIG. 5A



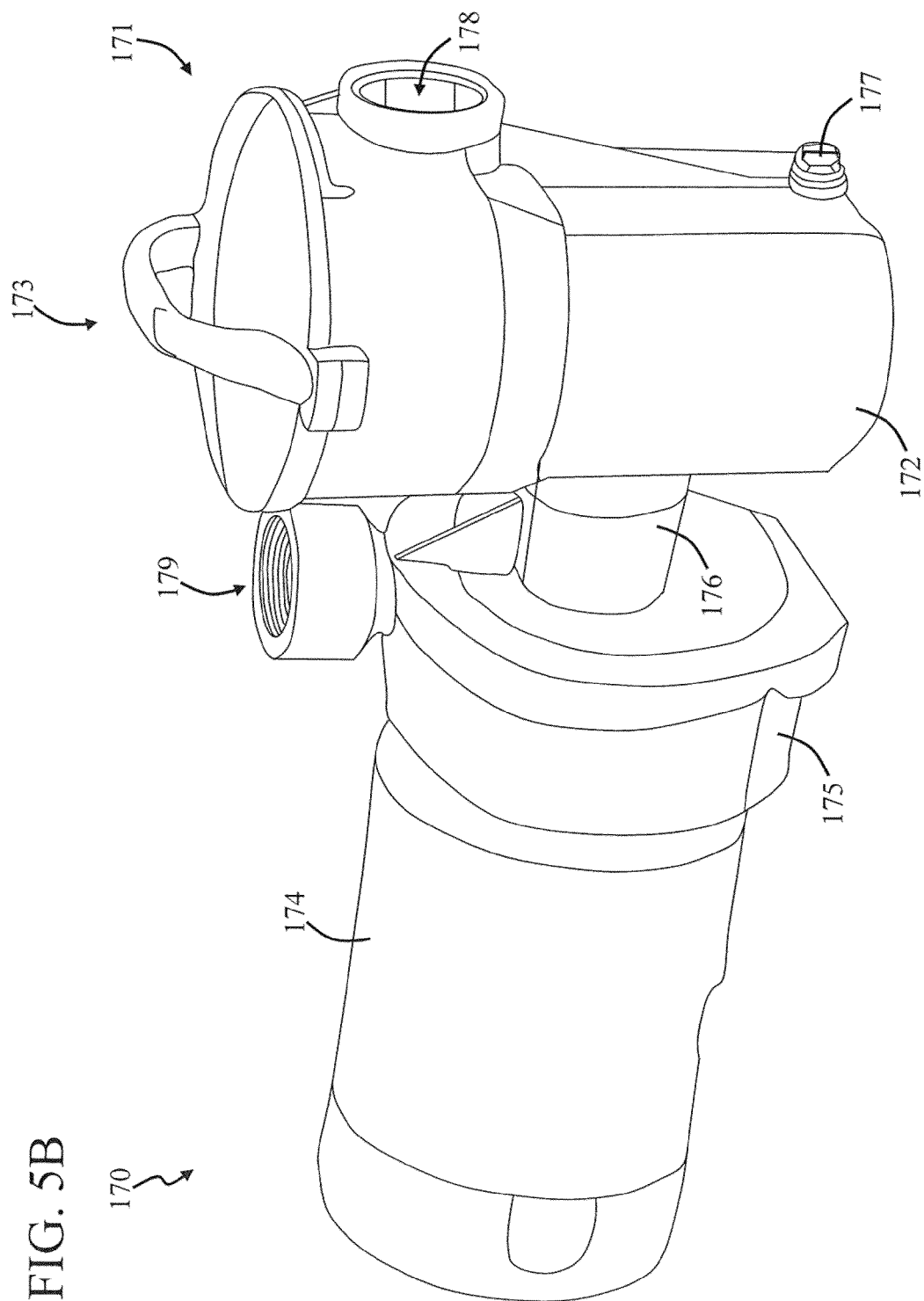


FIG. 5C

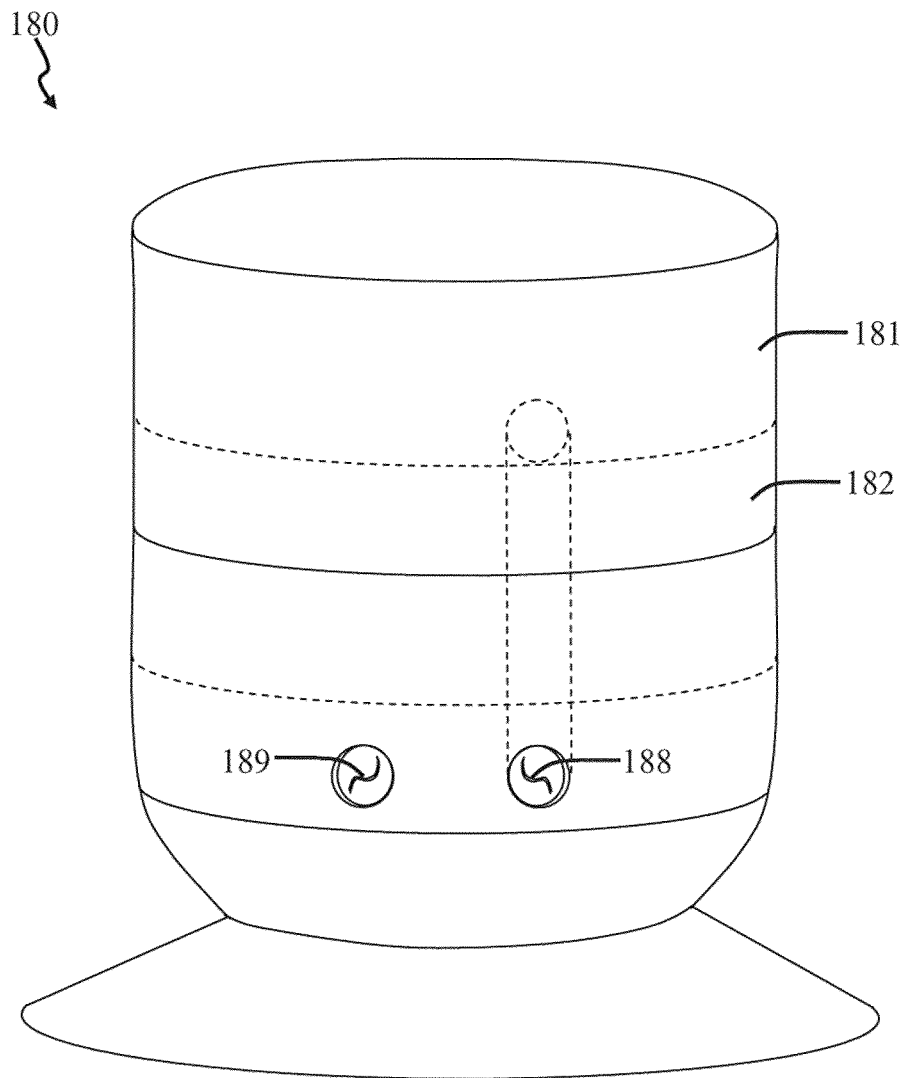


FIG. 5D

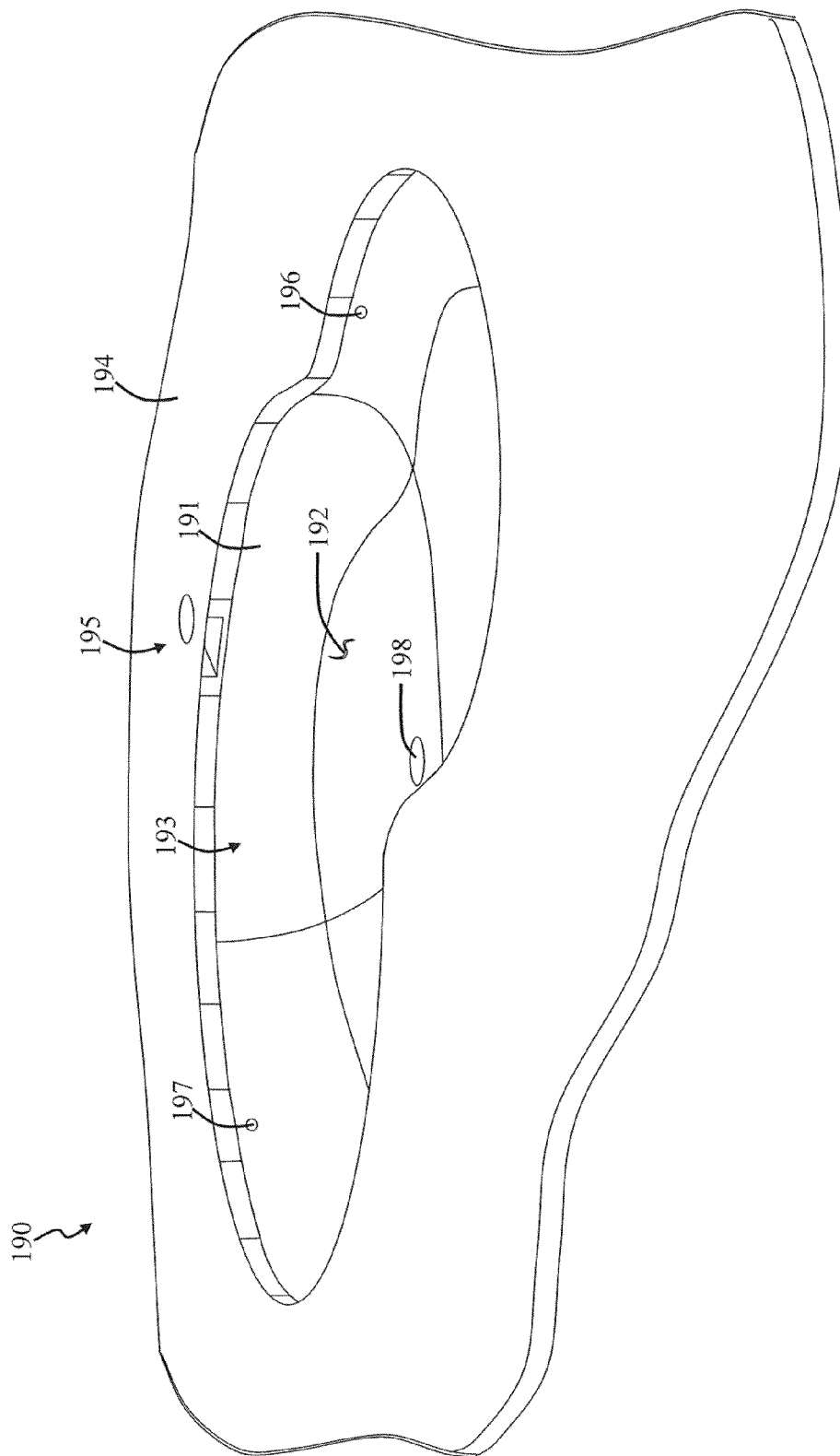


FIG. 5E

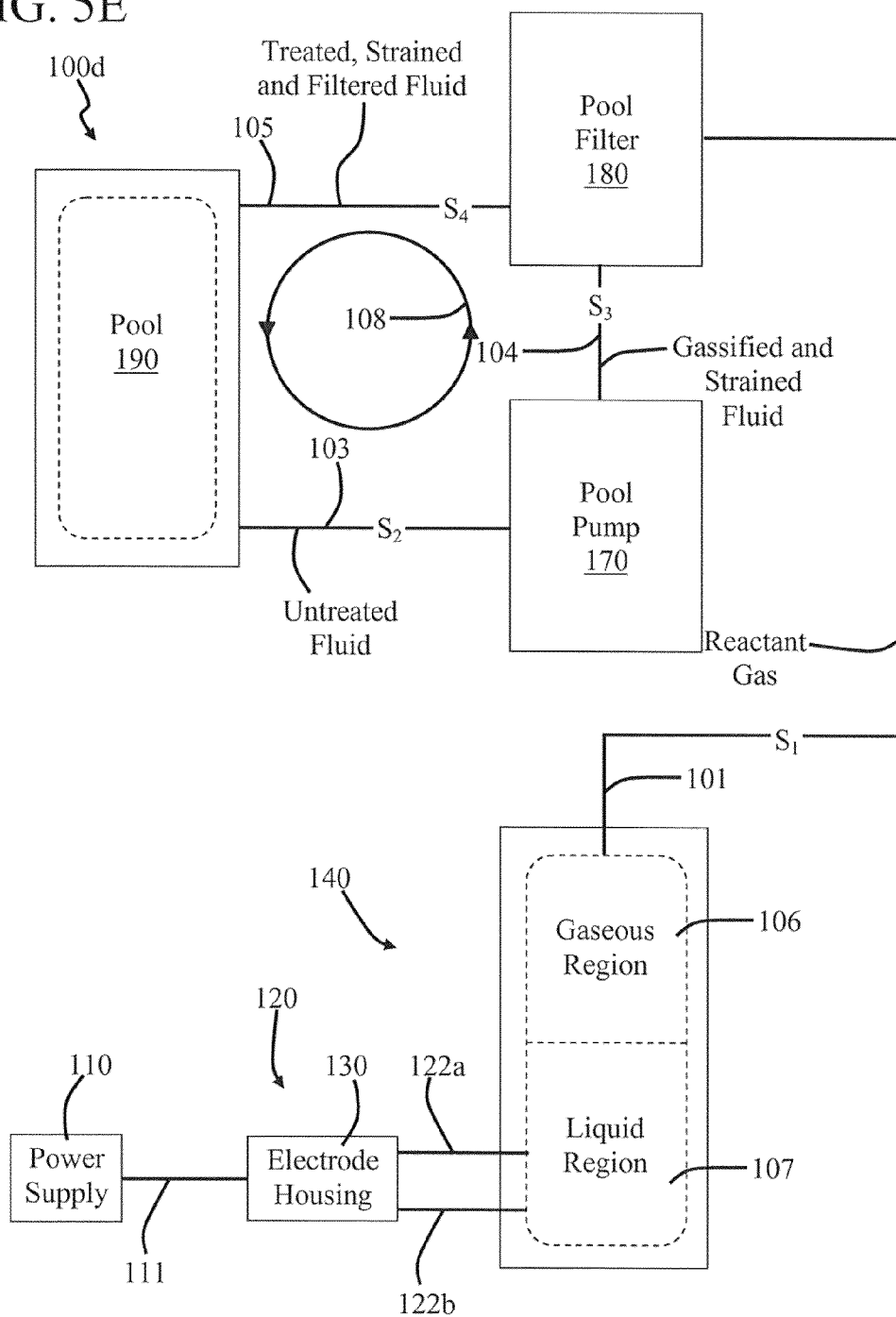


FIG. 5F

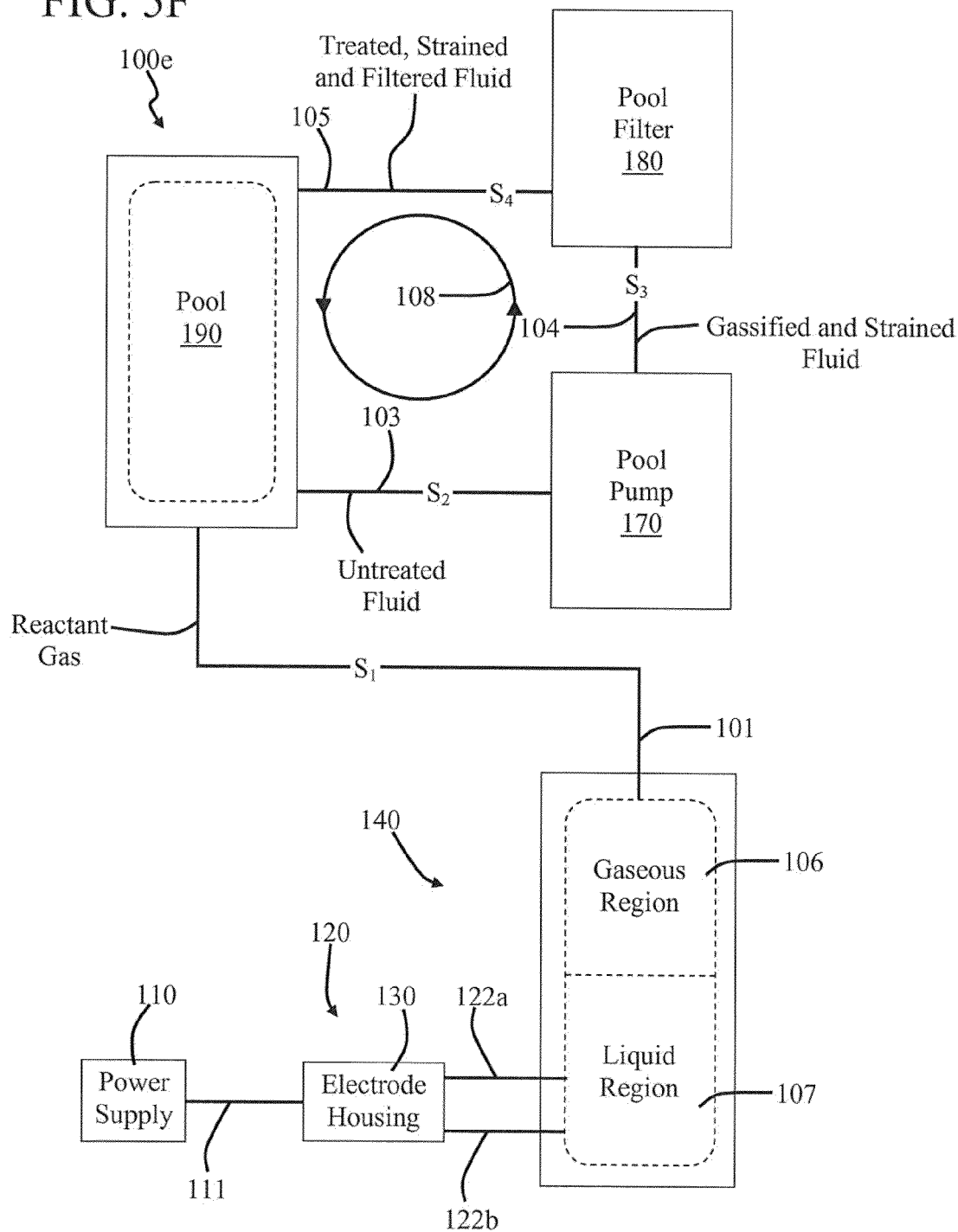


FIG. 6A

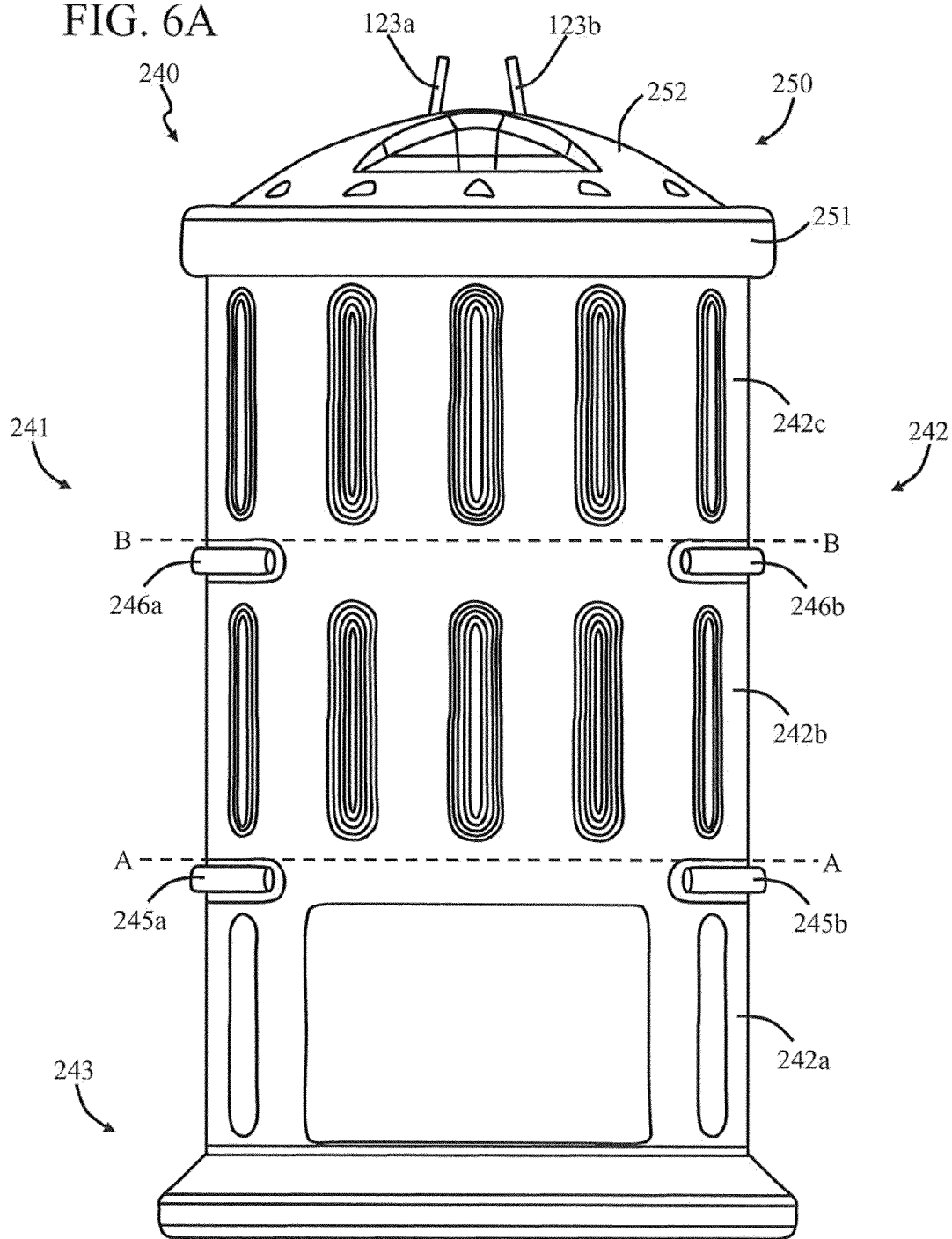


FIG. 6B

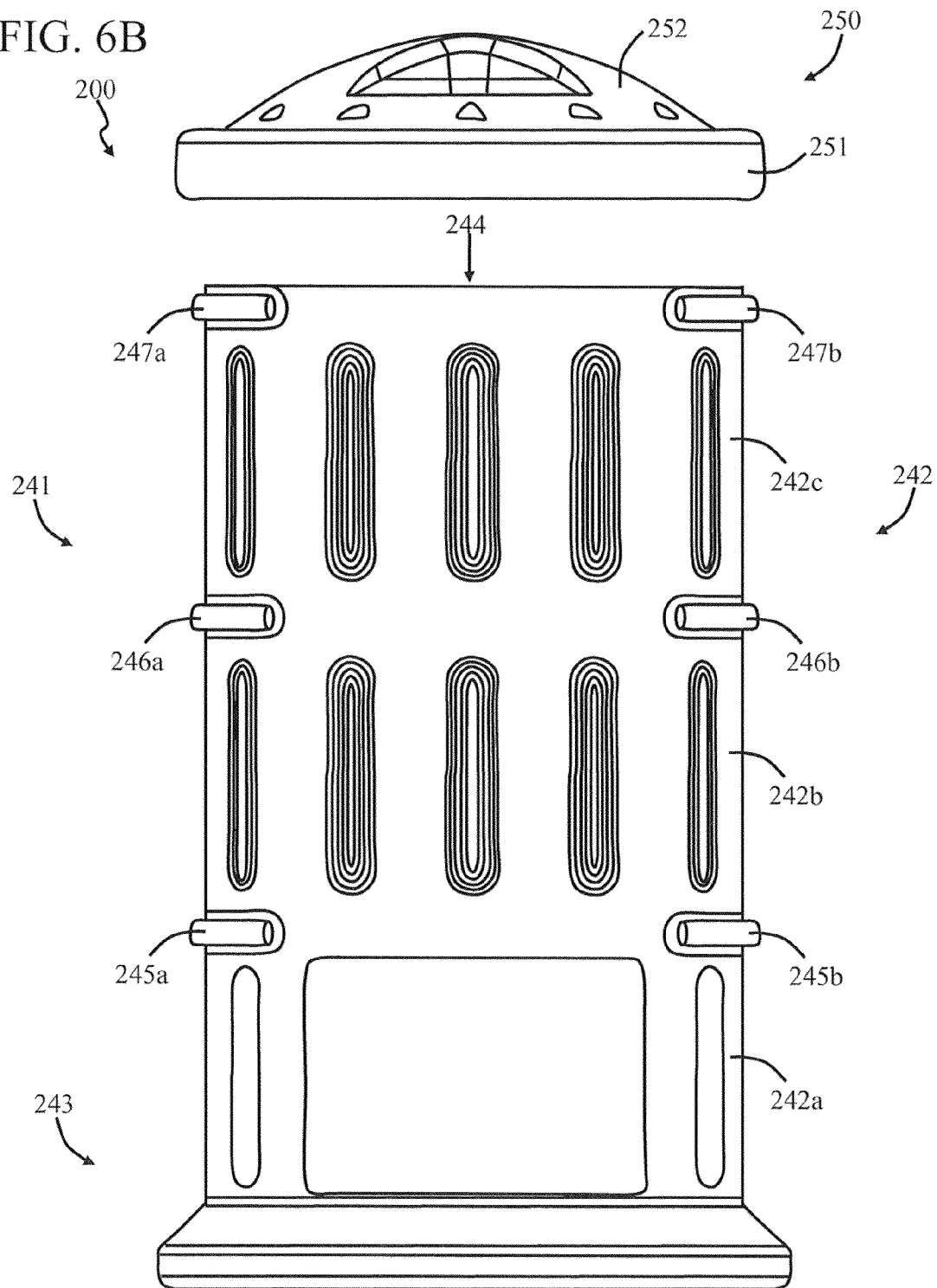


FIG. 6C

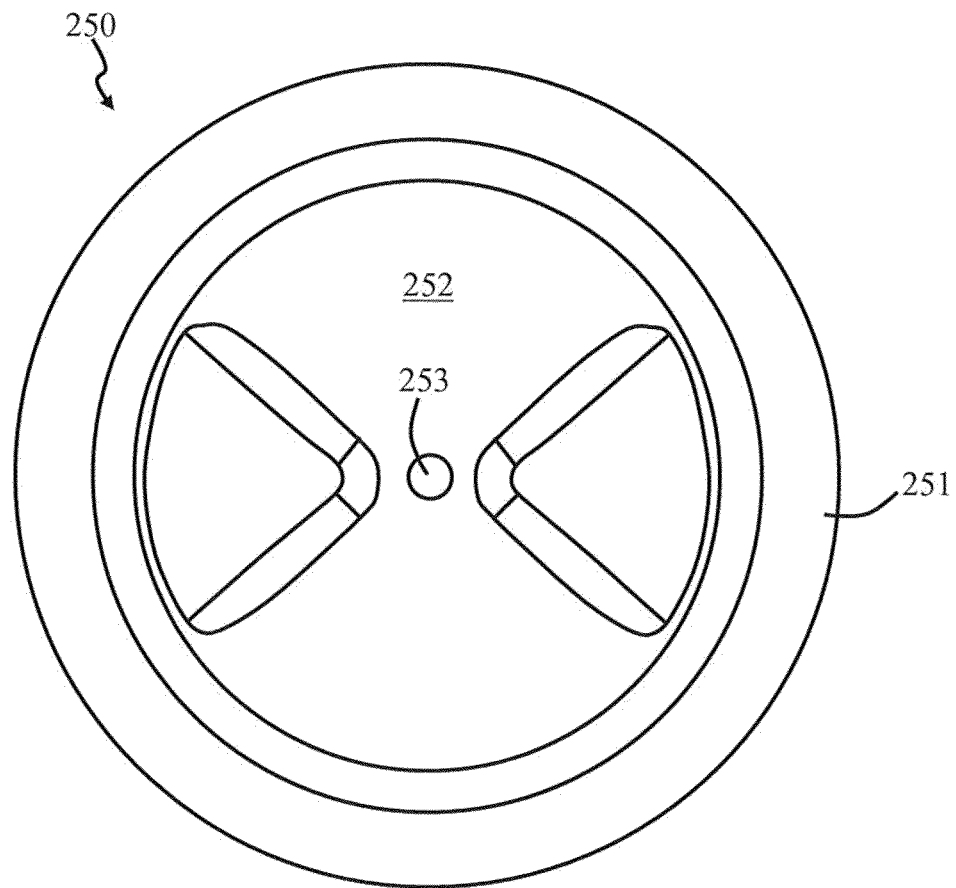


FIG. 6D

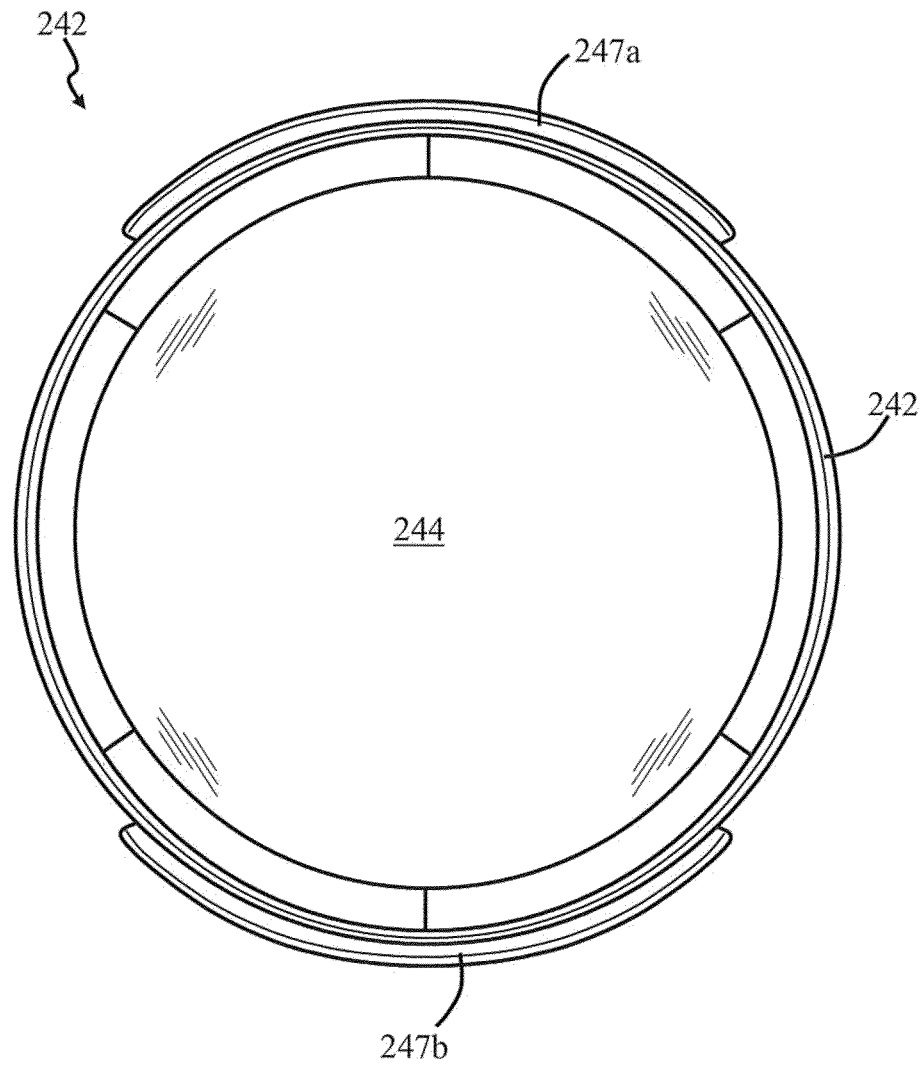


FIG. 6E

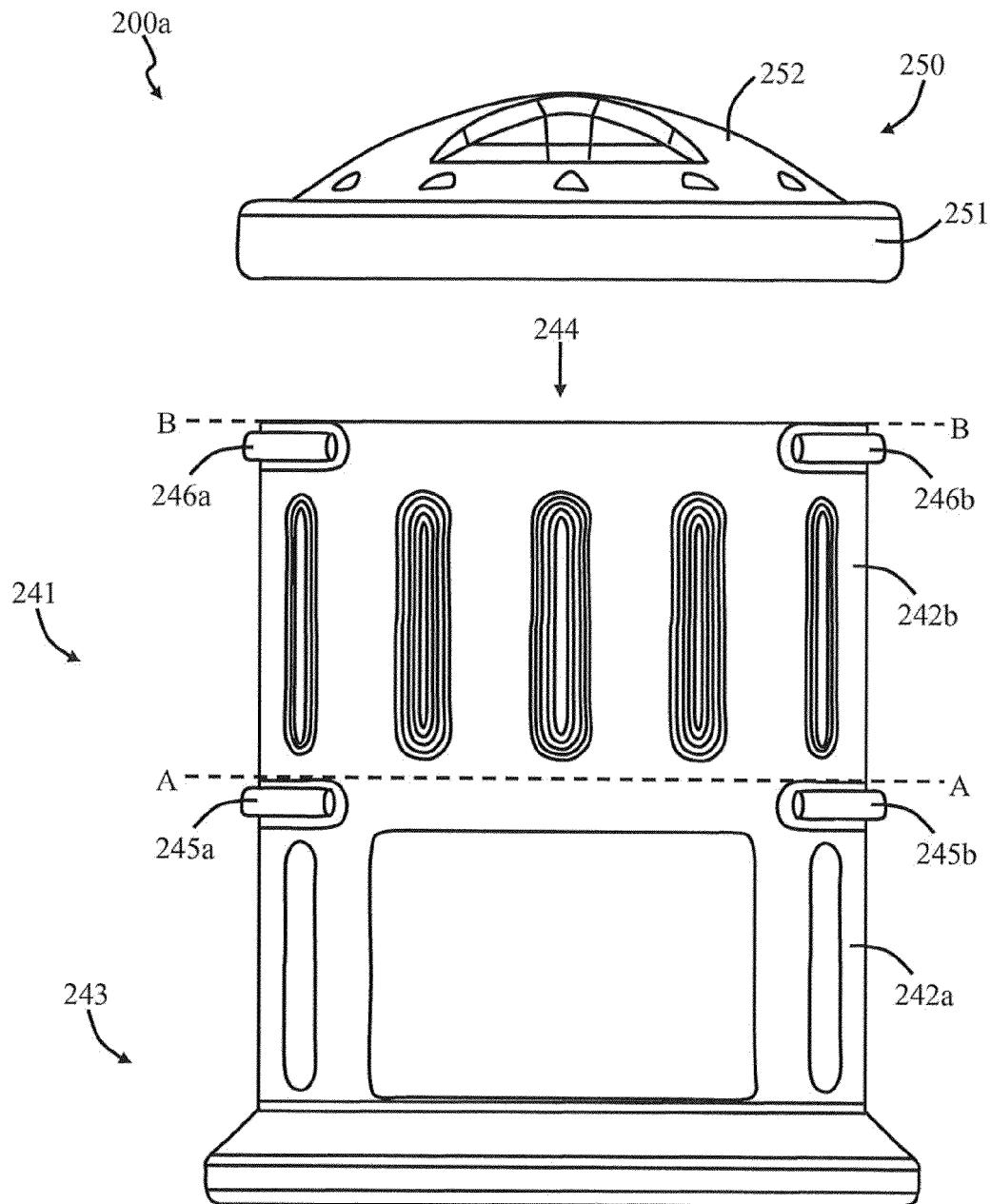
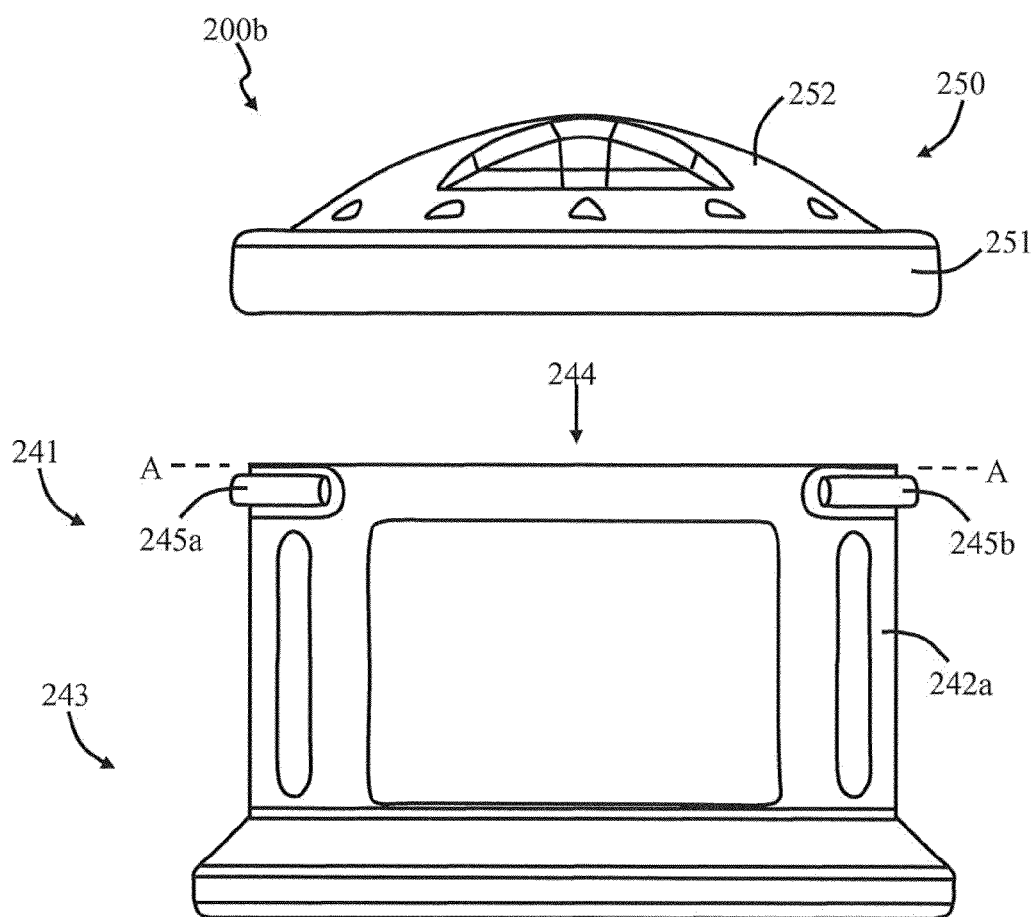


FIG. 6F



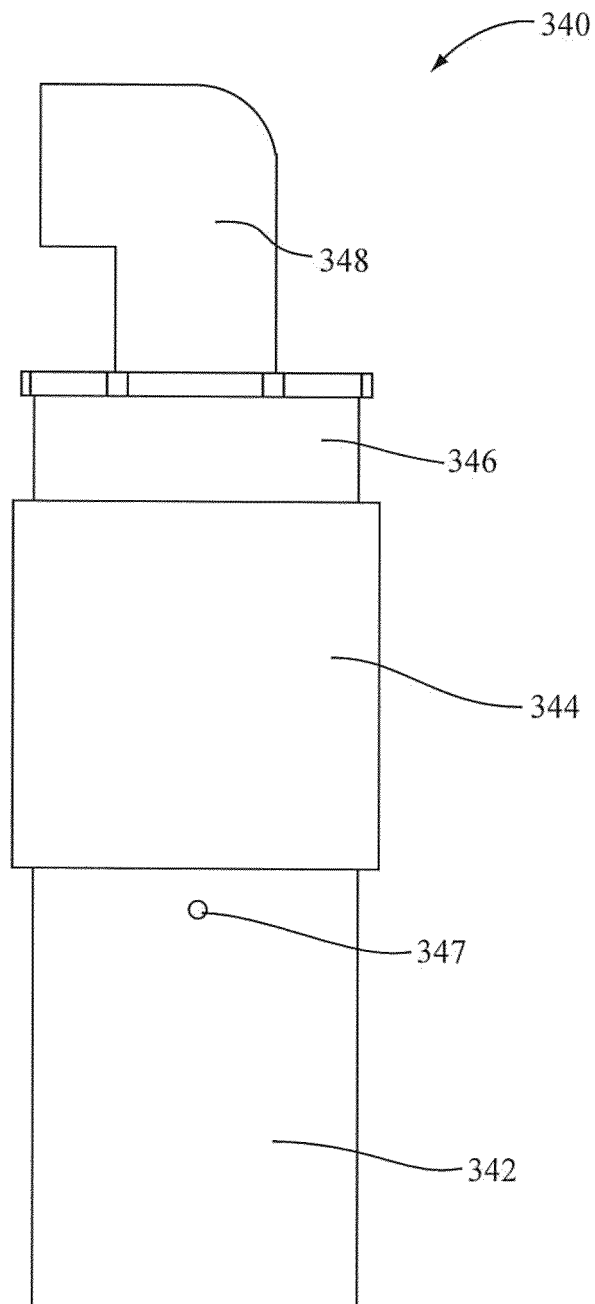


FIG. 7A

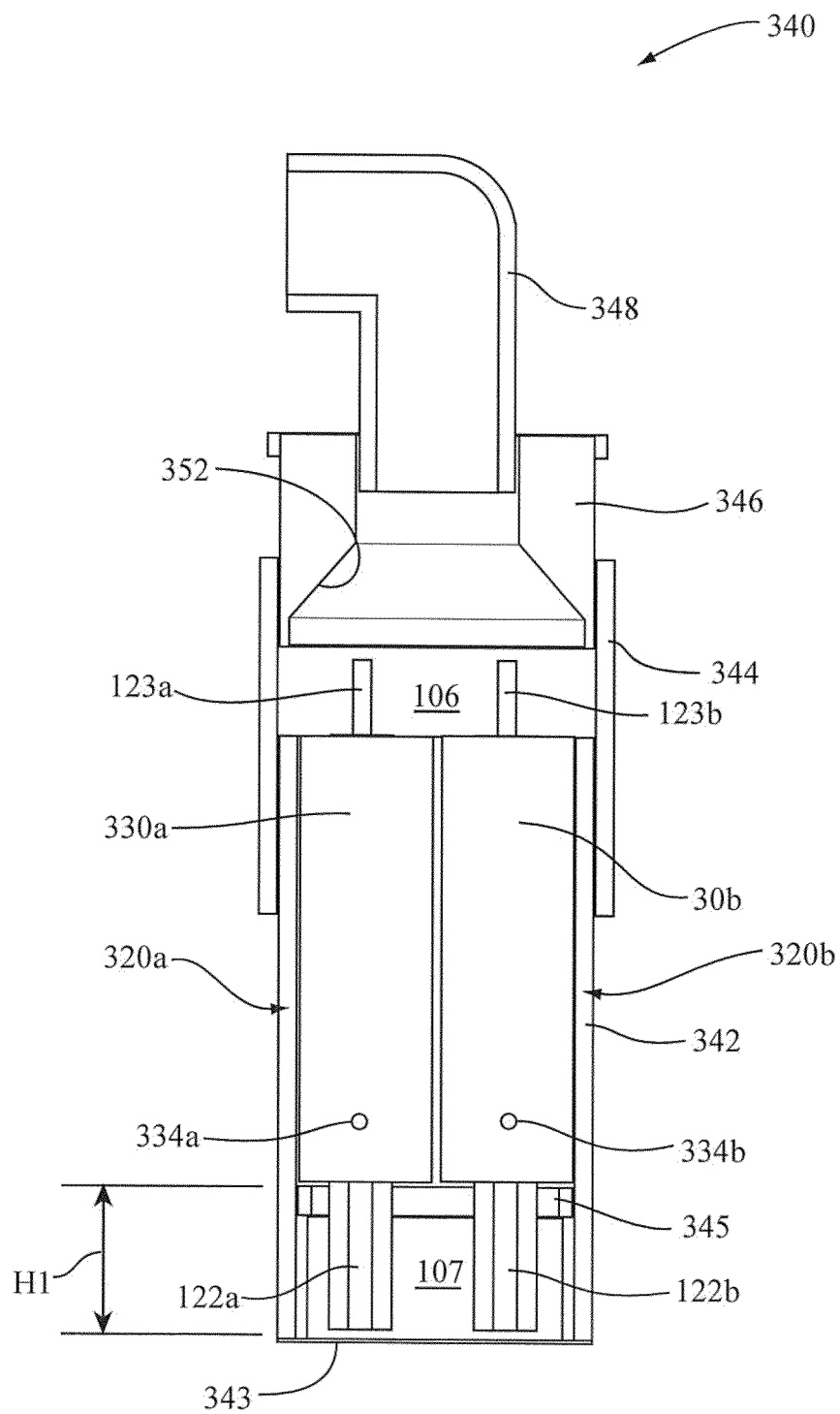


FIG. 7B

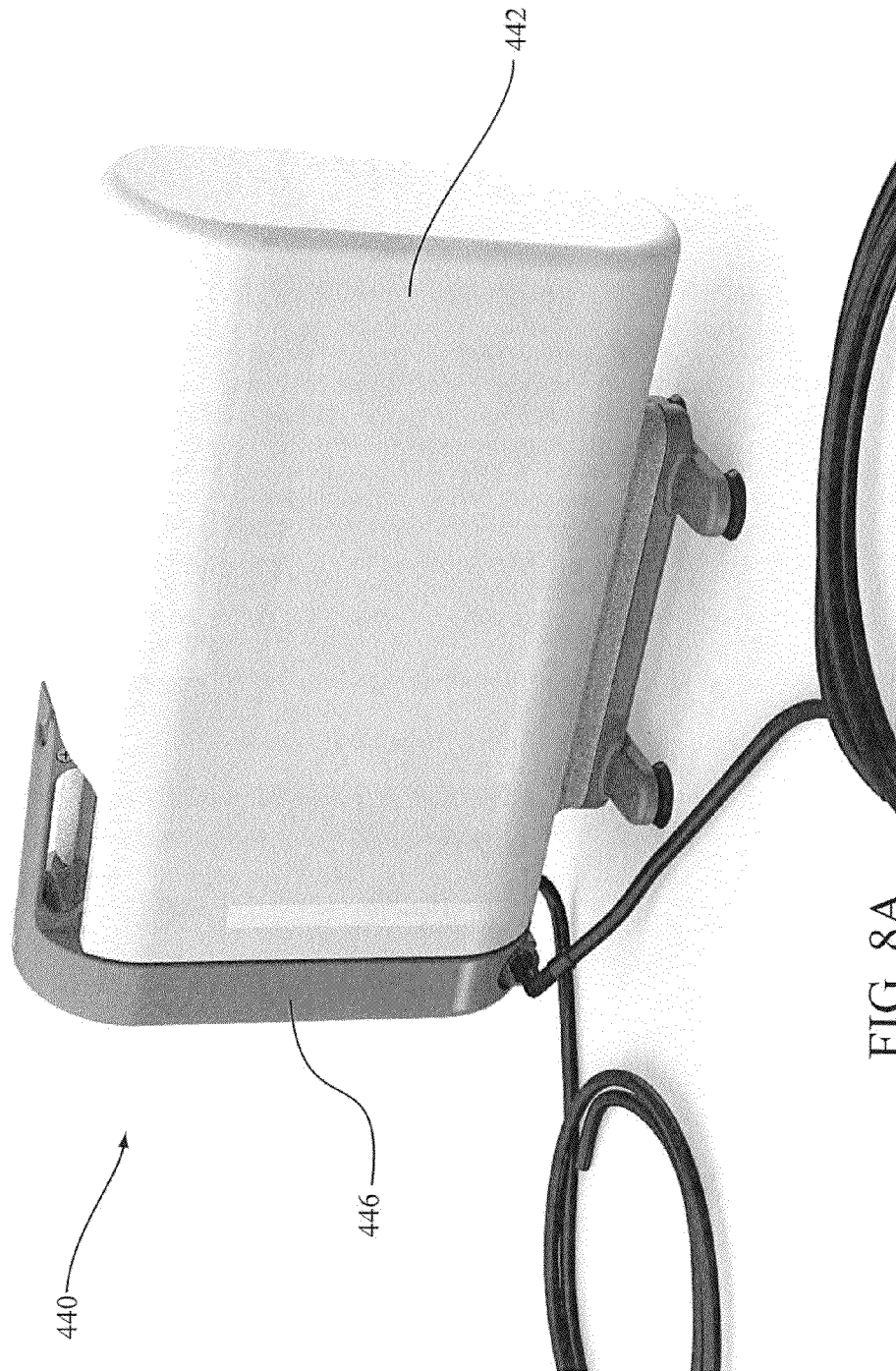


FIG. 8A

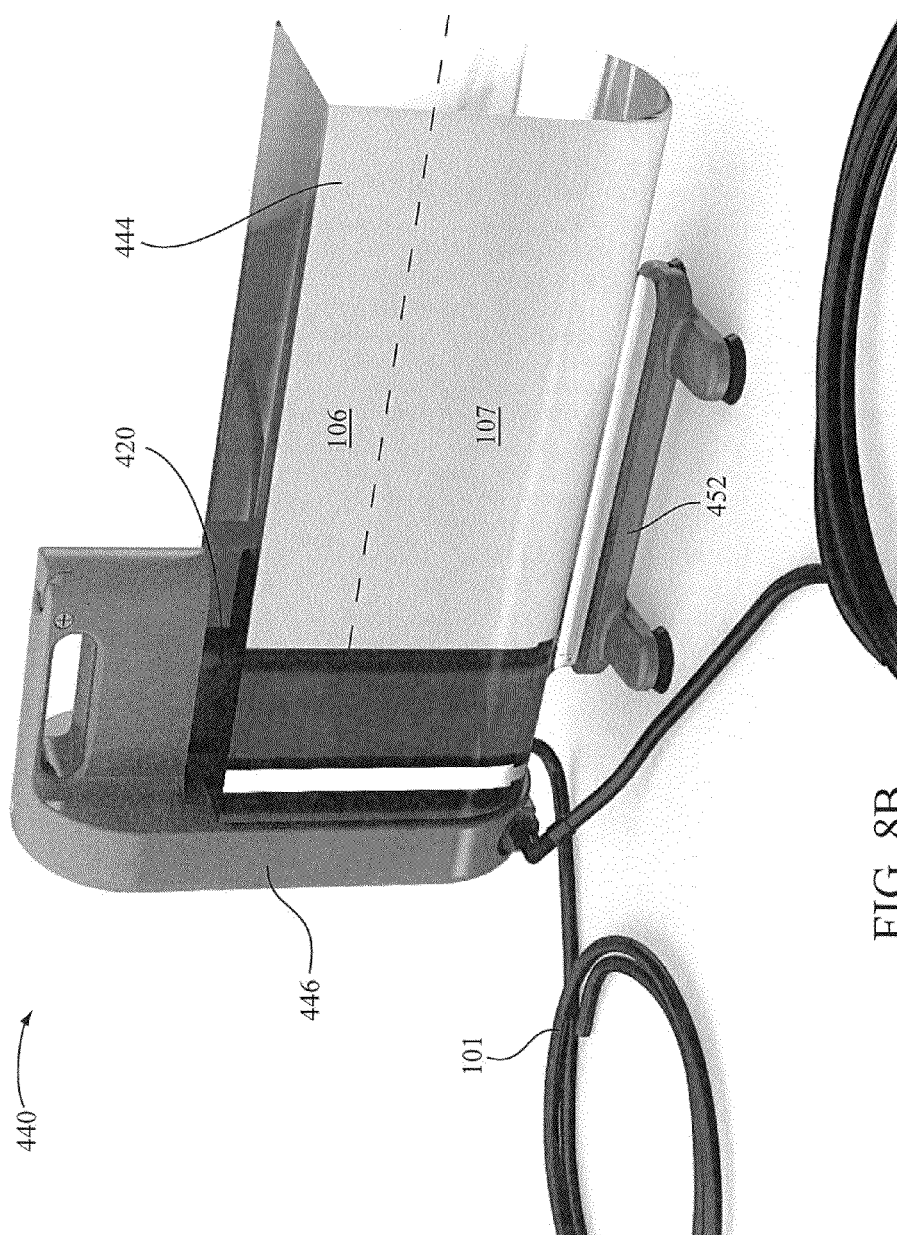


FIG. 8B

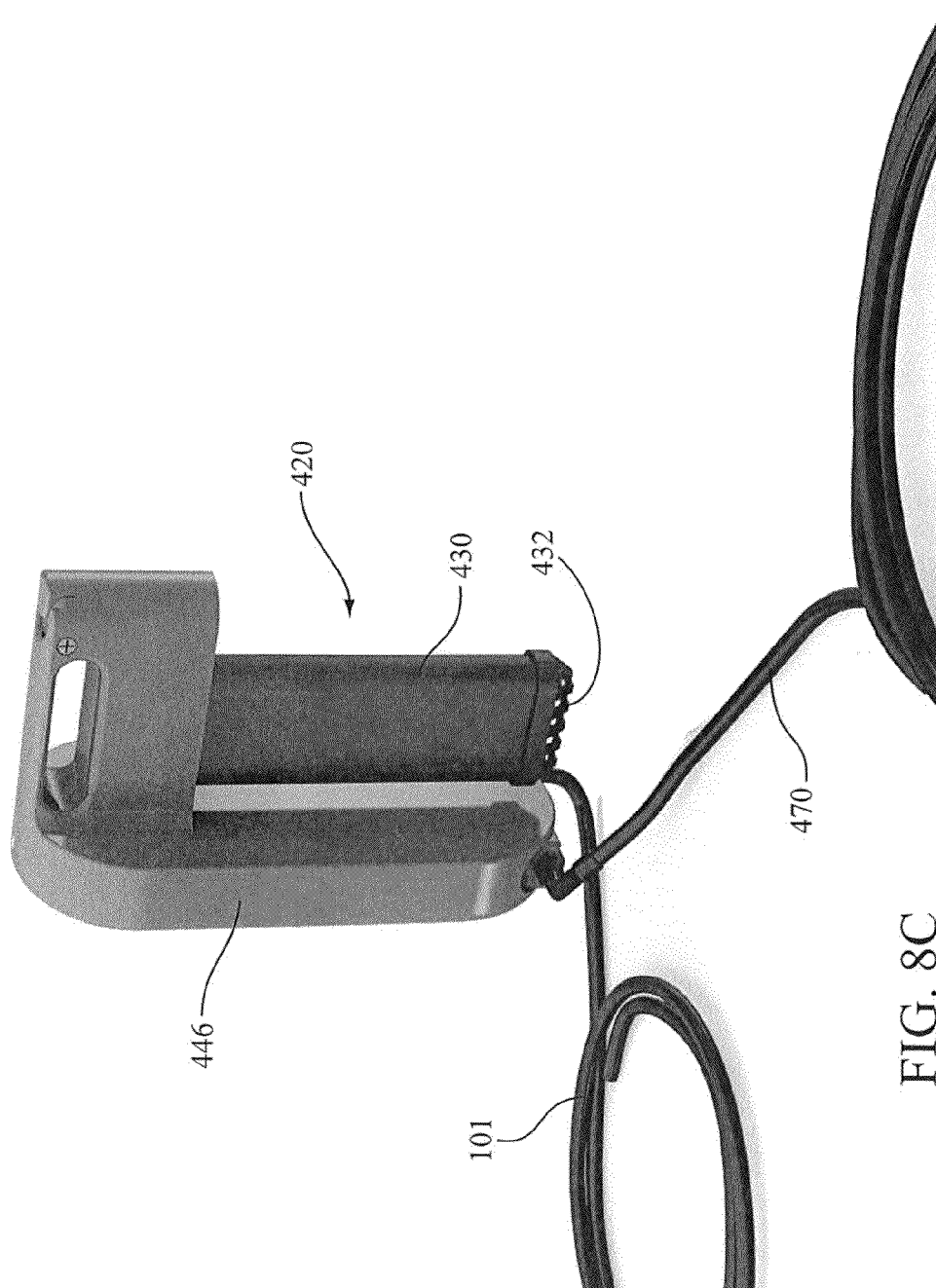


FIG. 8C

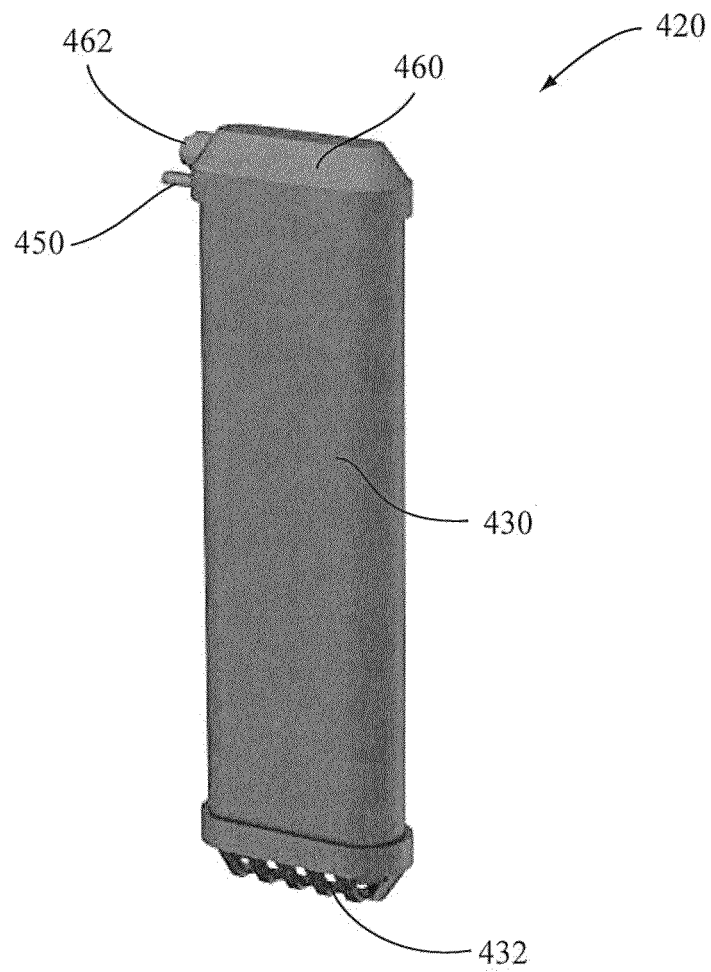


FIG. 8D

1

WATER MANAGEMENT SYSTEM**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application is a continuation-in-part of the earlier U.S. Utility Patent Application entitled "WATER CLEANING SYSTEM," Ser. No. 13/087,266, filed Apr. 14, 2011, now pending, which claims priority to U.S. Provisional Application No. 61/324,643, filed on Apr. 15, 2010, the contents of which are incorporated by reference as though fully set forth herein.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

This invention relates generally to a system for treating a liquid by using a gas.

2. Description of the Related Art

There are many different ways to treat a liquid, such as pool water, and most involve the use of a chemical. For example, most pools include chlorine in the water, wherein the chlorine reduces the amount of algae and bacteria. However, these chemicals affect the taste and odor of the water, which makes it uncomfortable to swim. Some pools include saltwater because algae and bacteria find it difficult to survive in saltwater. However, it is expensive to maintain a saltwater pool. More information regarding water cleaning systems and methods of cleaning water can be found in U.S. Pat. Nos. 3,926,802, 3,948,632, 4,098,602, 4,282,104, 5,332,511, 5,373,025, 5,541,150, 6,387,415 and 6,824,794, the contents of all of which are incorporated by reference as though fully set forth herein. While these reference may disclose systems suitable for their intended purposes, an improved water cleaning system is desirable.

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to a liquid managing system for treating a liquid. The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are diagrams of different embodiments of a liquid cleaning system.

FIGS. 1C and 1D are top plan and perspective views, respectively, of a solid piece which includes an additive, wherein the solid piece is used with the liquid cleaning system of FIGS. 1A and 1B.

FIG. 1E is a top plan view of another embodiment of a solid piece which includes an additive, wherein the solid piece includes an opening.

FIGS. 2A and 2B are perspective views of one embodiment of a gas generating system of the liquid cleaning system of FIG. 1B.

FIGS. 2C and 2D are side and side cut-away views, respectively, of the gas generating system of FIG. 1B.

FIG. 3A is a side view of one embodiment of an electrode assembly of the gas generating system of FIG. 1B.

FIG. 3B is a perspective view of an electrode of the electrode assembly of FIG. 3A.

FIG. 3C is a perspective view of another embodiment of an electrode assembly of the electrode assembly of FIG. 3A.

2

FIGS. 3D and 3E are top and bottom perspective views, respectively, of one embodiment of an electrode cap of the electrode assembly of FIG. 3A.

FIG. 3F is a perspective view of one embodiment of an electrode housing of the electrode assembly of FIG. 3A.

FIG. 4A is a side view of one embodiment of an electrode assembly of the gas generating system of FIG. 1B.

FIG. 4B is a perspective view of an electrode of the electrode assembly of FIG. 4A.

FIG. 4C is a perspective view of another embodiment of an electrode assembly of the electrode assembly of FIG. 4A.

FIGS. 4D and 4E are top and bottom perspective views, respectively, of one embodiment of an electrode cap of the electrode assembly of FIG. 4A.

FIG. 4F is a perspective view of one embodiment of an electrode housing of the electrode assembly of FIG. 4A.

FIG. 5A is a diagram of a system which includes the gas generating system of FIG. 1B in fluid communication with a pool.

FIG. 5B is a perspective view of one embodiment of a pool pump of the system of FIG. 5A.

FIG. 5C is a perspective view of one embodiment of a pool filter of the system of FIG. 5A.

FIG. 5D is a perspective view of one embodiment of the pool of the system of FIG. 5A.

FIGS. 5E and 5F are diagrams of different embodiments of systems which include the gas generating system of FIG. 1B in fluid communication with a pool.

FIGS. 6A and 6B are side views of another embodiment of a gas generating system, which can be used with the liquid cleaning system of FIG. 1B.

FIG. 6C is a top plan view of a vessel lid of the gas generating system of FIGS. 6A and 6B.

FIG. 6D is a top plan view of the vessel of the gas generating system of FIGS. 6A and 6B.

FIGS. 6E and 6F are side views of the gas generating system of FIGS. 6A and 6B having different sized vessels.

FIG. 7A is a side view of an embodiment of a gas generation system.

FIG. 7B is a section view of the embodiment of the gas generation system of FIG. 7A.

FIG. 8A is a perspective view of an embodiment of a gas generation system.

FIG. 8B is a perspective view of the internal components of the embodiment of FIG. 8A.

FIG. 8C is a perspective view of a portion of the components of the embodiment of FIG. 8A.

FIG. 8D is a perspective view of a cartridge used in the embodiment of FIG. 8A.

DETAILED DESCRIPTION OF THE INVENTION

The present invention involves a liquid cleaning system which cleans a liquid by removing contaminants therefrom. In some situations, the contaminants include algae and bacteria. The liquid cleaning system cleans the liquid by introducing a reactant gas into the liquid. The introduction of a gas into a liquid is sometimes referred to as sparging. The liquid cleaning system of the present invention sparges a reactant gas into the liquid. The reactant species of the reactant gas is chosen to treat the contaminants of the liquid to reduce their effectiveness. In this way, the liquid is cleaned. It should be noted that in the following figures, like reference characters indicate corresponding elements throughout the several views.

FIGS. 1A and 1B are diagrams of different embodiments of a liquid cleaning system, denoted as liquid cleaning systems

100a and **100b**, respectively. In this embodiment, liquid cleaning system **100a** includes a power supply **110** in communication with an electrode assembly **120** through a power cord **111**. Power supply **110** can be of many different types. In some embodiments, power supply **110** is an AC power supply and, in other embodiments, power supply is a DC power supply. An AC power supply provides a power signal with an amplitude that varies with time in a periodic manner. A DC power supply provides a power signal with an amplitude that is substantially constant with time. In some embodiments, the DC power supply provides a power signal with an amplitude which does not vary with time in a periodic manner. In this way, the DC power supply provides a non-periodic power signal. A DC power supply is useful because it is less expensive and less complicated than an AC power supply.

The amplitude of the power signal can have many different values. In some embodiments, the amplitude of the power supply is between 90 volts and 130 volts. In some embodiments, the amplitude of the power signal is between 200 volts and 240 volts. In some embodiments, the amplitude of the power supply is between 90 volts and 130 volts AC (VAC). In some embodiments, the amplitude of the power signal is between 200 volts and 240 volts AC (VAC). In some embodiments, the amplitude of the power supply is between 90 volts and 130 volts DC (VDC). In some embodiments, the amplitude of the power signal is between 200 volts and 240 volts DC (VDC).

Electrode assembly **120** includes an electrode housing assembly **130** and electrodes **122a** and **122b**, wherein electrodes **122a** and **122b** are in communication with a liquid region **107** of liquid cleaning system **100a**. Electrodes **122a** and **122b** are in communication with liquid region **107** because they can establish an electric field therethrough. The electric field is established in response to establishing a potential difference between electrodes **122a** and **122b**, as will be discussed in more detail below. It should be noted that embodiments of electrodes **122a** and **122b** are provided below with FIGS. **3a-3f** and FIGS. **4a-4f**.

Liquid region **107** includes a reactant liquid which is used to generate a reactant gas in response to the electric field being established through liquid region **107**. In particular, the reactant liquid is used to generate the reactant gas in response to the potential difference being established between electrodes **122a** and **122b**. It should be noted that the reactant gas includes reactant ions which are provided in response to the electric field being established through the reactant liquid. In particular, the reactant gas includes reactant ions which are provided in response to the potential difference being established between electrodes **122a** and **122b**. The reactant ion adjusts the pH of the reactant liquid, wherein the pH is a measure of the acidity or basicity of an aqueous solution. The reactant ion ionizes matter included with the liquid. The matter can be of many different types, such as algae and bacteria.

The reactant liquid can be of many different types. In some embodiments, the reactant liquid includes an acid. The acid of the reactant liquid can be of many different types, such as organic and inorganic acids. One type of inorganic acid that can be used is hydrochloric acid (muriatic acid). The hydrochloric acid is typically an aqueous solution. The concentration of the hydrochloric acid of the aqueous solution can be in many different ranges. In some embodiments, the concentration of the hydrochloric acid is six percent (6%) to thirty six percent (36%). In some embodiments, the concentration of the hydrochloric acid is five percent (5%) to forty percent (40%). In some embodiments, the concentration of the hydrochloric acid is less than fifty percent (50%). In one particular,

embodiment, the concentration of the hydrochloric acid is twenty-seven percent (27%) to thirty-three (33%).

In some embodiments, the reactant ion has a positive charge and, in other embodiments, the reactive ion has a negative charge. In some embodiments, the additive includes a metal. The metal can be of many different types, such as nickel, brass, titanium, steel, silver, graphite, bronze and/or gold. In some embodiments, the metal includes copper and/or a copper alloy. The amount of copper included can be in many different ranges. In some embodiments, the amount of copper used is 0.05 pounds per gallon of acid to 0.29 pounds of per gallon of acid. The copper and copper alloy form a positive reactant ion. In general, the amount of copper used is chosen to provide a desired pH to the reactant liquid.

The reactant liquid includes an additive which determines the type of reactant ion. In some embodiments, the additive is a liquid and, in other embodiments, the additive is a solid in the form of a solid piece of material. For example, as shown in FIGS. **1C** and **1D**, the additive is in the form of a solid piece of material embodied as solid piece **115a**, wherein solid piece **115a** is added to the acid of the reactant liquid. Solid piece **115a** dissolves in response to being added to the acid of the reactant liquid. It is useful for the additive to be a solid piece of material because it is easier, safer and less expensive to transport from one location to another, such as through the mail.

Further, it is useful for the additive to be a solid piece of material because its size can be adjusted to adjust the amount of additive of the solid piece. In this way, the amount of additive added to the reactant liquid is adjustable. For example, FIG. **1E** is a top plan view of a solid piece **115b** which includes the additive. In this embodiment, solid piece **115b** includes a plurality of openings **116**, whose number and size is chosen so that a desired amount of additive is included with solid piece **115b**. The amount of additive of solid piece **115b** increases and decreases as the number of openings decreases and increases, respectively. Further, the amount of additive of solid piece **115b** increases and decreases as the size of the openings decreases and increases, respectively. In this way, the amount of additive of solid piece **115b** can be adjusted to so that solid piece **115b** includes a desired amount of additive. It should be noted that, in general, solid piece **115b** includes one or more openings. However, a plurality of openings are shown in FIG. **1E** for illustrative purposes.

It is useful to be able to adjust the amount of additive of solid piece **115b** because the amount of additive chosen depends on the size of the body of liquid it is desired to treat. In general, more and less additive is desired as the size of the body of fluid increases and decreases, respectively. Further, it is useful to be able to adjust the amount of additive of solid piece **115b** because the amount of additive chosen depends on the time it is desired to treat the body of liquid. In general, more and less additive is desired as the amount of desired time increases and decreases, respectively. It is useful to be able to adjust the amount of additive of solid piece **115b** because the amount of additive chosen depends on the size of liquid region **107**. In general, more and less additive is desired as the size of liquid region **107** increases and decreases, respectively. Liquid regions of different sizes are discussed below with FIGS. **6A**, **6E** and **6F**.

In this embodiment, liquid cleaning system **100a** includes a gaseous region **106** in fluid communication with liquid region **107** through a conduit **102**. Gaseous region **106** includes the reactant gas, which is formed from the reactant liquid of liquid region **107**. In particular, gaseous region **106** includes the reactant gas, which is formed in response to the electric field being established through liquid region **107**.

5

Further, gaseous region **106** includes the reactant gas, which is formed in response to the potential difference being established between electrodes **122a** and **122b**. As mentioned above, the reactant gas includes reactant ions provided by the reactant liquid of liquid region **107**, wherein the reactant ions are provided in response to the electric field being established. It should be noted that a conduit allows a fluid to flow therethrough. The conduit can be of many different types, such as a pipe and hose.

In this embodiment, liquid cleaning systems **100a** includes a conduit **101** in fluid communication with gaseous region **106**. Conduit **101** is in fluid communication with conduit **102** through gaseous region **101**, and conduit **101** is in fluid communication with a body of liquid (not shown), such as a body of water. The reactant gas formed from the reactant liquid of liquid region **107** flows upwardly through conduit **102**, gaseous region **106** and conduit **101**, and to the body of liquid.

The body of liquid can be of many different types. In the embodiment of FIG. 5A, the body of liquid is the water of a swimming pool, and conduit **101** is in fluid communication with the water of the swimming pool through a pool pump and pool filter, as will be discussed in more detail below.

The reactant gas is chosen so that it treats the body of liquid. The reactant gas can treat the body of liquid in many different ways. In some situations, the pH of the body of liquid is adjusted in response to the flow of the reactant gas. In some situations, the amount of bacteria of the body of liquid is reduced in response to the flow of the reactant gas. In some situations, the amount of algae of the body of liquid is reduced in response to the flow of the reactant gas. In this way, system **100a** operates as a liquid treatment system.

In operation, power supply **110** provides a power signal to electrode assembly **120** through power cord **111**, and electrode assembly **120** establishes the electric field through liquid region **107**. In particular, electrode assembly **120** establishes the electric field through liquid region **107** in response to establishing the potential difference between electrodes **122a** and **122b**.

As mentioned above, the reactant gas is provided to gaseous region **106** through conduit **102** in response to electric field being established through liquid region **107**. In particular, the reactant gas is provided to gaseous region **106** through conduit **102** in response to the potential difference being established between electrodes **122a** and **122b**. The reactant gas flows through conduit **101** and into the body of liquid (not shown).

In the embodiments in which the body of liquid is water, the reactant ions of the reactant gas treat the body of water. The reactant ions can treat the body of water in many different ways. In some situations, the pH of the body of water is adjusted in response to the flow of the reactant ions. In some situations, the amount of bacteria of the body of water is reduced in response to the flow of the reactant ions. In some situations, the amount of algae of the body of water is reduced in response to the flow of the reactant ions. The ionization of the bacteria and algae reduces the likelihood that the bacteria and algae will survive in the body of water. Further, the ionization of the bacteria and algae reduces the likelihood that the bacteria and algae will reproduce in the body of water. In this way, system **100a** operates as a water treatment system.

In the embodiments in which the body of liquid is water and the additive includes copper, the reactant copper ions of the reactant gas treat the body of water. The reactant copper ions can treat the body of water in many different ways. In some situations, the pH of the body of water is adjusted in response to the flow of the reactant copper ions. In some situations, the amount of bacteria of the body of water is

6

reduced in response to the flow of the reactant copper ions. In some situations, the amount of algae of the body of water is reduced in response to the flow of the reactant copper ions. The ionization of the bacteria and algae reduces the likelihood that the bacteria and algae will survive in the body of water. Further, the copper ionization of the bacteria and algae reduces the likelihood that the bacteria and algae will reproduce in the body of water. In this way, system **100a** operates as a water treatment system. It should be further understood that other metals may be used as the additive in a water treatment system and accordingly, while copper is discussed, other metals may be substituted with similar results and operation.

In FIG. 1b, liquid cleaning system **100b** includes power supply **110** in communication with electrode assembly **120** through power cord **111**. Electrode assembly **120** includes electrode housing assembly **130** and electrodes **122a** and **122b**. In this embodiment, liquid cleaning system **100b** includes a gas generating system **140**, which includes gaseous region **106** and liquid region **107** in fluid communication with each other. One embodiment of gas generating system **140** is discussed in more detail below with FIGS. 2a-2d. Electrodes **122a** and **122b** are in communication with gas generating system **140**. In particular, electrodes **122a** and **122b** are in communication with liquid region **107**, as discussed in more detail above with FIG. 1a.

In this embodiment, liquid cleaning systems **100b** includes conduit **101** in fluid communication with gas generating system **140**. In particular, conduit **101** is in fluid communication with gaseous region **106** and the body of water, as discussed in more detail above with FIG. 1A.

FIGS. 2A and 2B are perspective views of one embodiment of gas generating system **140**, and FIGS. 2C and 2D are side and side cut-away views, respectively, of gas generating system **140**. In this embodiment, gas generating system **140** includes a vessel lid **150** carried by a vessel **141**. Vessel **141** and vessel lid **150** can include many different materials. Vessel **141** and vessel lid **150** include a material that is resistant to the chemicals of the reactant liquid and reactant gas. There are many different types of materials that are resistant to the chemicals of the reactant liquid and reactant gas, such as a plastic. There are many different types of plastics available, such as polypropylene and polyvinyl chloride.

Vessel **141** can be of many different types. In this embodiment, vessel **141** includes a vessel body **142**, which includes a vessel base **143** at one end and a vessel body opening **144** (FIG. 2B) at an opposed end. Vessel base **143** supports vessel body **142** in an upright position so that vessel body opening **144** faces upwardly. It should be noted that, in some embodiments, vessel base **143** and vessel body **142** are repeatedly moveable between coupled and uncoupled conditions. Vessel base **143** and vessel body **142** are shown in the coupled condition in FIGS. 2A, 2B, 2C and 2D. In other embodiments, vessel base **143** and vessel body **142** are a single integral piece.

In this embodiment, vessel lid **150** includes a vessel lid base **151** and vessel lid dome **152**. Vessel lid **150** is repeatedly moveable between positions engaged with and disengaged from vessel body **142**, wherein vessel lid **150** is engaged with vessel body **142** in FIGS. 2A, 2C and 2D, and vessel lid **150** is disengaged from vessel body **142** in FIG. 2B. It should be noted that vessel lid **150** covers vessel body opening **144** when it is engaged with vessel body **142**. Further, as shown in FIG. 2D, gas generating system **140** includes a vessel chamber **149**, which is enclosed by vessel **141** and vessel lid **150**. Vessel chamber **149** will be discussed in more detail below.

In this embodiment, vessel lid **150** is fastened to vessel body **142** with a fastener **155** and rod **156**. In this embodiment, rod **156** is a threaded rod, which extends through vessel lid **150** and vessel body **142**, and fastener **155** is a threaded nut which is threadingly engaged with rod **156** to fasten vessel lid **150** to vessel body **142**. It should be noted that the seal formed between vessel lid **150** and vessel body **142** becomes stronger and weaker in response to tightening and untightening, respectively, fastener **155** with rod **156**. It should also be noted that rod **156** can be coupled to vessel body **142** in many different ways. In some embodiments, vessel rod **156** is coupled to vessel base **143**, and extends upwardly therefrom through vessel body opening **144**.

In this embodiment, vessel lid **150** includes a gas output port **153** which extends through vessel dome **152**. Gas output port **153** is in fluid communication with vessel chamber **149** through vessel dome **152**, and receives conduit **101** (FIGS. 1A and 1B).

In this embodiment, vessel lid **150** includes a gas vent **154** which allows the pressure of a gas in vessel chamber **149**, such as the reactant gas, to vent therethrough. Hence, gas vent **154** reduces the likelihood that the pressure of the gas in vessel chamber **149** will be too high.

As shown in FIG. 2D, vessel **141** includes drain conduits in fluid communication with each other, wherein drain conduit **146** extends upwardly and drain conduit **147** extends radially. In this embodiment, drain conduit **146** includes an upwardly facing drain opening **145** which faces vessel body opening **144**. It should be noted that drain opening **145** faces vessel lid **150** when it is engaged with vessel body **142**.

As mentioned above, rod **156** can be coupled to vessel body **142** in many different ways. In some embodiments, rod **156** is coupled to drain conduit **146** (not shown). In some embodiments, rod **156** extends through drain opening **145** and is coupled to drain conduit **146** (not shown).

In this embodiment, drain conduit **147** extends through vessel body **142** and is in fluid communication with a drain outlet **148**. It should be noted that drain conduit **146** extends through liquid region **107** (FIG. 1B), and drain opening **145** is in fluid communication with gaseous region **106**.

In this embodiment, gas generating system **140** includes electrode assemblies **120a** and **120b**, as shown in FIGS. 2C and 2D, and electrode cords **160a** and **160b**, as shown in FIGS. 2A and 2B, which are coupled to electrode assemblies **120a** and **120b**, respectively. In particular, electrode cords **160a** and **160b** are coupled to electrodes terminals **123a** and **123b** of electrode assemblies **120a** and **120b**, respectively. Electrode assemblies **120a** and **120b** will be discussed in more detail below with FIGS. 3A-3E and FIGS. 4A-4E. Further, as will be discussed in more detail below, electrodes terminals **123a** and **123b** are included with electrodes **122a** and **122b**, respectively, of FIGS. 1A and 1B.

In this embodiment, electrode cords **160a** and **160b** include power cords **161a** and **161b**, respectively. Power cords **161a** and **161b** are in communication with electrodes **123a** and **123b**, respectively, through electrode connectors **163a** and **163b**, respectively.

In this embodiment, electrode cords **160a** and **160b** includes power cord connectors **162a** and **162b**, respectively. Power cord connectors **162a** and **162b** are in communication with electrode connectors **163a** and **163b**, respectively, through power cords **161a** and **161b**, respectively. Further, power cord connectors **162a** and **162b** are in communication with electrodes **123a** and **123b**, respectively, through corresponding electrode connectors **163a** and **163b** and power cords **161a** and **161b**.

It should be noted that electrode cords **160a** and **160b** are in communication with a power supply, such as power supply **110** of FIGS. 1A and 1B. In particular, power cord connectors **162a** and **162b** are coupled with power cord **111**. In this way, the power supply provides power to electrode assemblies **120a** and **120b** through electrode cords **160a** and **160b**, respectively.

It should be noted that electrode assemblies **120a** and **120b** extend through gaseous region **106** and liquid region **107**. In some embodiments, however, electrode assemblies **120a** and **120b** extend through liquid region **107** and do not extend through gaseous region **106**. Further, it should be noted that distal ends of electrode assemblies **120a** and **120b** terminate proximate to liquid conduit **146**. Distal ends of electrode assemblies **120a** and **120b** terminate proximate to drain opening **145**. Distal ends of electrode assemblies **120a** and **120b** terminate in liquid region **107**. Proximal ends of electrode assemblies **120a** and **120b** terminate proximate to vessel dome **152**. Further, proximal ends of electrode assemblies **120a** and **120b** terminate in gaseous region **106**.

As shown in FIG. 2D, gaseous region **106** and liquid region **107** are included with vessel chamber **149**, wherein gaseous region **106** extends through a portion of vessel chamber **149** proximate to vessel lid, as well as through a portion of vessel chamber **149** which extends through an upper portion of vessel body **142**. Liquid region **107** extends through a portion of vessel chamber **149** which extends through a lower portion of vessel body **142**.

For reference purposes, a boundary **139** extends between the upper and lower portions of vessel body **142**, wherein boundary **139** corresponds with an upper level of the reactant liquid of gaseous region **106** is above boundary **139** and liquid region **107** is below boundary region **107**. It should be noted that boundary **139** extends through electrode assemblies **120a** and **120b** so that the distal ends of electrode assemblies **120a** and **120b** extend through liquid region **107**. In particular, the distal ends of electrode assemblies **120a** and **120b** terminate in liquid region **107**. It should also be noted that boundary **139** extends through drain conduit **146** so that drain opening **145** extends through gaseous region **106**. In this way, the reactant liquid of liquid region **107** flows through drain opening **145** in response to being driven above boundary **139**. Hence, the reactant liquid is restricted from flowing upwardly through gaseous region **106**. In this way, the liquid reactant of liquid region **107** is restricted to the level of drain opening **145**.

FIG. 3A is a side view of one embodiment of electrode assembly **120a**. In this embodiment, electrode assembly **120a** includes electrode **122a**, which extends through an electrode housing **130a** and electrode cap **125a**. Electrode cap **125a** is carried by electrode housing **130a**, and electrode terminal **123a** extends upwardly through electrode cap **125a**. It should be noted that electrode housing **130a** is included with electrode housing of FIGS. 1A and 1B, and electrode **122a** and electrode terminal **123a** are shown in FIGS. 1A and 1B.

FIG. 3B is a perspective view of electrode **122a**. In this embodiment, electrode **122a** includes electrode terminal **123a** coupled to an electrode body **124a**, wherein electrode body **124a** has a circular cross-sectional shape. As shown in FIG. 3A, electrode body **130a** extends through electrode housing **130a** and electrode cap **125a**. In particular, electrode body **124a** is housed by electrode housing **130a** and electrode cap **125a**. Electrode body **124a** can include many different types of conductive materials. In some embodiments, electrode body **124a** includes graphite and titanium. In some embodiments, electrode body **124a** includes a material compressed into a graphite rod. For

example, in some embodiments, electrode body **124a** includes nickel, brass, titanium, copper, copper alloy, steel, silver, bronze and/or gold compressed into the graphite rode.

Electrode body **124a** can have many different dimensions. In this embodiment, electrode body **124a** has a longitudinal dimension d_5 and a radial dimension d_3 . Dimensions d_5 and d_3 can have many different values. In some embodiments, dimension d_5 is one inch (1 inch) to seventy two inches (72 inches). In some embodiments, dimension d_3 is one-half of an inch (0.5 inches) to two inches (2 inches). The values of dimensions d_3 and d_5 depend on the amount of reactant gas it is desired to provide.

FIG. 3C is a perspective view of another embodiment of an electrode, which is denoted as electrode **122c**. In this embodiment, electrode **122c** includes electrode terminal **123a** coupled to an electrode body **124c**, wherein electrode body **124c** has a hexagonal cross-sectional shape. Electrode body **124c** can include the same material as electrode body **124a**.

FIGS. 3D and 3E are top and bottom perspective views, respectively, of one embodiment of electrode cap **125a**. In this embodiment, electrode cap **125a** includes an electrode cap body **126a**, wherein electrode cap body **126a** includes an electrode terminal opening **127a** at one end and electrode cap threads **128a** at an opposed end. Electrode terminal opening **127a** is sized and shaped so that electrode terminal **123a** can extend therethrough, and electrode cap threads **128a** allow electrode cap **125a** to be threadingly engaged with electrode housing body **130a**, as will be discussed in more detail presently.

Electrode cap **125a** includes a material that is resistant to the chemicals of the reactant liquid and reactant gas. There are many different types of materials that are resistant to the chemicals of the reactant liquid and reactant gas, such as a plastic. There are many different types of plastics available, such as polypropylene and polyvinyl chloride. It should be noted that the material of electrode cap **125a** is insulative. In general, the material of electrode cap **125a** is more insulative than the material of electrode **122a**.

FIG. 3F is a perspective view of one embodiment of electrode housing **130a**. In this embodiment, electrode housing **130a** includes an electrode housing body **131a**, wherein electrode housing body **131a** includes an electrode opening **132a** at one end and an electrode housing body opening **134a** at an opposed end. In this embodiment, electrode opening **132a** faces longitudinally along electrode housing body **131a** and electrode housing body opening **134a** faces radially.

Electrode housing body **130a** includes electrode housing body threads **133a** proximate to electrode opening **132a**. Electrode housing body threads **133a** allow electrode cap **125a** to be threadingly engaged with electrode housing body **130a**. In particular, electrode housing body threads **133a** can be threadingly engaged with electrode cap threads **128a**. In this way, electrode housing body **130a** and electrode cap **125a** are repeatably moveable between engaged and disengaged conditions with each other.

As indicated by an indication arrow **135a**, electrode housing body opening **134a** is circular in shape and has a dimension d_1 which corresponds with its diameter. It should be noted, however, that electrode housing body opening **134a** can have other shapes, such as rectangular and triangular. As will be discussed in more detail below, the flow of reactant ions through electrode housing body opening **134a** increases and decreases in response to dimension d_1 being larger and smaller, respectively. In this way, dimension d_1 can be chosen to provide a desired flow of reactant ions through electrode housing body **130a**.

Electrode housing body **130a** includes a material that is resistant to the chemicals of the reactant liquid and reactant gas. There are many different types of materials that are resistant to the chemicals of the reactant liquid and reactant gas, such as a plastic. There are many different types of plastics available, such as polypropylene and polyvinyl chloride. It should be noted that the material of electrode housing body **130a** is insulative. In general, the material of electrode housing body **130a** is more insulative than the material of electrode **122a**.

FIG. 5A is a diagram of a circulation system **100c** which flows a fluid in a circuit **108**. In this embodiment, circulation system **100c** includes power supply **110** in communication with gas generating system **140** through power cord **111**. As discussed in more detail above, gas generating system **140** includes electrode assembly **120** with electrodes **122a** and **122b** in communication with liquid region **107** (FIG. 1B). Gas generating system **140** includes gaseous region **106**, and provides a reactant gas S_1 through conduit **101**. Hence, reactant gas S_1 flows between gas generating system **140** and pool pump **170** through conduit **101**.

In this embodiment, circulation system **100c** includes a pool pump **170** in fluid communication with gas generating system **140**. In particular, pool pump **170** is in fluid communication with gaseous region **106** through conduit **101** and receives reactant gas S_1 . Reactant gas S_1 can be of many different types, such as those discussed in more detail above. Further, pool pump **170** can be of many different types. One embodiment of pool pump **170** is discussed in more detail with FIG. 5B.

In this embodiment, pool pump **170** receives an untreated fluid S_2 through a conduit **103** and provides a gassified and strained fluid S_3 . Fluid S_3 is gassified in response to reactant gas S_1 being combined with untreated fluid S_2 . Further, fluid S_3 is strained in response to flowing through pool pump **170**. In this embodiment, reactant gas S_1 is combined with untreated fluid S_2 in pool pump **170**, as will be discussed in more detail below.

In this embodiment, circulation system **100c** includes a pool **190** in fluid communication with pool pump **170**. In particular, pool **190** is in fluid communication with pool pump **170** through conduit **103** and provides untreated fluid S_2 . Hence, untreated fluid S_2 flows between pool pump **170** and pool **190** through conduit **103**.

As discussed in more detail below, untreated fluid S_2 includes water and contaminants, wherein it is desirable to remove the contaminants therefrom and return the water to pool **190**. The contaminants can be of many different types, such as particles, algae and bacteria. The particles can be of many different types, such as dirt and debris. The debris can be of many different types, such as leaves. One embodiment of pool **190** is discussed in more detail with FIG. 5D.

In this embodiment, circulation system **100c** includes a pool filter **180** in fluid communication with pool pump **170**. In particular, pool filter **180** is in fluid communication with pool pump **170** through a conduit **104** and receives gassified and strained fluid S_3 . Hence, gassified and strained fluid S_3 flows between pool pump **170** and pool filter **180** through conduit **104**.

Pool filter **180** is in fluid communication with pool **190**. In particular, pool filter **180** is in fluid communication with pool **190** through a conduit **105** and provides a treated, strained and filtered fluid S_4 to pool **190**. Hence, treated, strained and filtered fluid S_4 flows between pool filter **180** and pool **190** through conduit **105**. Fluid S_4 is treated and filtered in response to flowing through pool filter **180**, and fluid S_4 is strained in response to flowing through pool pump **170**. Pool

11

filter **180** can be of many different types. One embodiment of pool filter **180** is discussed in more detail with FIG. **5C**.

In operation, reactant gas S_1 is provided to pool pump **170** through conduit **101** in response to the operation of gas generating system **140**. Further, untreated fluid S_2 flows to pool pump **170** through conduit **103** in response to the operation of pool pump **170**. Reactant gas S_1 and untreated fluid S_2 are combined and strained in pool pump **170**, and gassified and strained fluid S_3 is formed in response.

Gassified and strained fluid S_3 flows to pool filter **180** through conduit **104**, in response to the operation of pool pump **170**, and is treated and filtered so that treated, strained and filtered fluid S_4 is formed in response. Treated, strained and filtered fluid S_4 flows to pool **190** through conduit **105**, in response to the operation of pool pump **170**, to complete circuit **108**.

FIG. **5B** is a perspective view of one embodiment of pool pump **170** of circulation system **100c**. In this embodiment, pool pump **170** includes a pump strainer assembly **171** in fluid communication with an impeller housing **175** through a conduit **176**. In this embodiment pump strainer assembly **171** includes a strainer pot **172** and strainer lid **173**, wherein strainer pot **172** houses a strainer basket (not shown). Strainer pot **172** includes a pump influent line **178** proximate to strainer lid **173**, and a strainer drain **177** away from strainer lid **173**. Pump influent line **178** is in fluid communication with conduit **176** through the strainer basket so that a fluid flowing therebetween is strained. The fluid is strained because the strainer basket removes debris, such as leaves, therefrom.

In this embodiment, pool pump **170** includes an impeller (not shown) operatively coupled to a pump motor **174** through a pump shaft (not shown), wherein the impeller is positioned in impeller housing **175**. When pool pump **170** has an on condition, pump motor **174** drives the pump shaft and the impeller rotates in response. Further, when pool pump **170** has an off condition, pump motor **174** does not drive the pump shaft and the impeller does not rotate in response. Pool pump **170** is repeatably moveable between the on and off conditions. In some situations, pool pump **170** is repeatably moveable between the on and off conditions in response to the operation of a timer.

Pool pump **170** includes a pump outlet line **179**, wherein pump outlet line **179** extends from impeller housing **175**. Pump outlet line **179** is in fluid communication with conduit **176** through impeller housing **175**. Hence, pump outlet line **179** is in fluid communication with pump influent line **178** through the strainer basket, conduit **176** and impeller housing **175**. The fluid flows between pump influent line **178** and pump outlet line **179** in response to the rotation of the impeller. Further, fluid flows between strainer drain **177** and pump outlet line **179** in response to the rotation of the impeller.

In operation, strainer drain **177** is coupled to gas generating system **140** through conduit **101** (FIG. **5A**) so that reactant gas S_1 flows through strainer drain **177**. Reactant gas S_1 flows between strainer drain **177** and pump outlet line **179** through conduit **176** in response to the rotation of the impeller.

Pump influent line **178** is coupled to pool **190** through conduit **104** (FIG. **5A**) so that untreated fluid S_2 flows through pump influent line **178**. Untreated fluid S_2 flows between pump influent line **178** and pump outlet line **179** through the strainer basket and conduit **176** in response to the rotation of the impeller.

It should be noted that reactant gas S_1 is combined with untreated fluid S_2 so that untreated fluid S_2 is gassified in response. It should also be noted that the impeller of impeller

12

housing **175** can facilitate the combining of reactant gas S_1 and untreated fluid S_2 . In this way, untreated fluid S_2 is gassified in response to flowing through pool pump **170**. Further, untreated fluid S_2 flows through the strainer basket so that it is strained in response. In this way, untreated fluid S_2 is strained in response to flowing through pool pump **170**.

Gassified and strained fluid S_3 is formed in response to untreated fluid S_2 being strained and combined with reactant gas S_1 . Gassified and strained fluid S_3 flows through pump outlet line **179** in response to the rotation of the impeller. In this way, pool pump **170** operates as a pump. Gassified and strained fluid S_3 flows to pool filter **180** through pump outlet line **179** and conduit **103**, as will be discussed in more detail presently.

FIG. **5C** is a perspective view of one embodiment of pool filter **180** of circulation system **100c**. In this embodiment, pool filter **180** includes a pool filter body **181** with a filter influent line **188** and filter outlet line **189**. In this embodiment, filter influent line **188** is in fluid communication with pool pump **170**. In particular, conduit **103** is coupled to pump outlet line **179** (FIG. **5B**) and filter influent line **188** so that gassified and strained fluid S_3 flows therebetween.

In this embodiment, filter outlet line **189** is in fluid communication with pool **190** (FIG. **5A**). In particular, conduit **105** is coupled to filter outlet line **189** (FIG. **5B**) and pool **190** so that treated, strained and filtered fluid S_4 flows therebetween, as shown in FIG. **5A**. It should be noted that pool filter **180** includes a filtering material **182**, wherein the fluid flowing between filter influent line **188** and filter outlet line **189** flows through filtering material **182**. Filtering material **182** can be of many different types. In this embodiment, filtering material **182** includes sand so that pool filter **180** operates as a sand filter. A sand filter uses a sand material to filter the fluid. It should be noted that pool filter **180** can be of many different types of filters, such as a cartridge pool filter, diatomaceous earth (DE) pool filter, a charcoal filter and a mineral filter. A cartridge filter typically uses a spun polyester material to filter the fluid. A DE pool filter uses a material commonly referred to as diatomaceous earth to filter the fluid. A charcoal filter uses a material commonly referred to as diatomaceous earth to filter the fluid. A mineral filter uses a mineral material, such as calcium, magnesium, potassium and/or sodium, to filter the fluid.

Filtering material **182** filters gassified and strained fluid S_3 in response to gassified and strained fluid S_3 flowing between filter influent line **188** and filter outlet line **189** so that treated, strained and filtered fluid S_4 is formed in response. Gassified and strained fluid S_3 is filtered in response to the sand removing contaminants from the water. The contaminants can be of many different types, such as debris, algae and/or bacteria. Hence, gassified and strained fluid S_3 of filter influent line **188** includes more contaminants than treated, strained and filtered fluid S_4 of outlet line **189**.

It should be noted that the species of reactant gas S_2 is typically filtered by the sand of pool filter **180** so that treated, strained and filtered fluid S_4 of outlet line **189** includes less of the species than gassified and strained fluid S_3 . Hence, the sand of pool filter **180** restricts the amount of reactants species that flows between filter influent line **188** and filter outlet line **189**. This is desirable because it is desirable to restrict the amount of the species that is flowed to pool **190**. In this way, a person using pool **190** is exposed to a reduced amount of the reactant species. It should be noted that, in other systems, the contaminants are reduced by introducing a reactant species, such as chlorine, in the pool **190**. In this way, the person using pool **190** is undesirably exposed to a significant amount of the chlorine.

13

It should be noted that the contaminants are typically held by the sand, and reactant gas S_2 of gassified and strained fluid S_3 treats the contaminants of the sand. For example, the sand holds the algae and bacteria of gassified and strained fluid S_3 , and reactant gas S_2 reduces their effectiveness. Reactant gas S_2 can reduce the effectiveness of algae and bacteria in many different ways. For example, in some situations, reactant gas S_2 reduces the ability of the algae and/or bacteria to reproduce. In some situations, reactant gas S_2 kills the algae and/or bacteria. In this way, treated, strained and filtered fluid S_4 is formed.

It should be noted that reactant gas S_2 is in pool filter 180 when pool pump 170 is in the off condition. Hence, reactant gas S_2 treats the contaminants of the sand when pool pump 170 has the off condition. This is useful so that the effectiveness of the algae and bacterial can be reduced when the pool pump has the on and off condition.

FIG. 5D is a perspective view of one embodiment of pool 190 of circulation system 100c. In this embodiment, pool 190 includes a pool basin 191 having a basin opening 192, wherein pool basin 191 extends through a pool deck 194. Pool basin 191 holds a body of water 193. It should be noted that body of water 193 can correspond to the body of water discussed above.

In this embodiment, pool 190 includes inlets 196 and 197 are in fluid communication with pool filter 180 through conduit 105. In particular, conduit 105 is coupled to filter outlet line 188 and inlets 196 and 197. Further, pool 190 includes a drain 198 and skimmer 195 which are in fluid communication with pool pump 170 through conduit 104. In particular, conduit 105 is coupled to pump influent line 178 and drain 198 and skimmer 195.

It should be noted that reactant gas S_1 can be introduced into pool 190 in many other ways. For example, FIG. 5E is a diagram of a liquid cleaning system 100d, wherein conduit 101 is coupled between gas generating system 140 and pool filter 180. In this way, reactant gas S_1 flows through conduit 101 between gas generating system 140 and pool filter 180. In this embodiment, conduit 101 can be coupled to pool filter 180 so that it is in fluid communication with filter influent line 188 and/or filter outlet line 189.

FIG. 5F is a diagram of a liquid cleaning system 100e, wherein conduit 101 is coupled between pool 190 and gas generating system 140. In this way, reactant gas S_1 flows through conduit 101 between gas generating system 140 and pool 190.

It should be noted that conduit 101 can be coupled between gas generating system 140 and many other locations of liquid cleaning system 100c of FIG. 5A. For example, conduit 101 can be coupled between gas generating system 140 and conduit 104. Further, conduit 101 can be coupled between gas generating system 140 and conduit 105. It should be noted that gas generating systems can include conduit 101 coupled between gas generating system 140 and a plurality of other locations. For example, in some embodiments, conduit 101 is coupled to gas generating system 140 and pool pump 170 and conduit 101. In other embodiments, conduit 101 is coupled to gas generating system 140 and pool pump 170 and pool filter 180. In some embodiments, conduit 101 is coupled to gas generating system 140 and pool pump 170, pool filter 180 and pool 190.

FIGS. 6A and 6B are side views of another embodiment of a gas generating system, which is denoted as gas generating system 240. Gas generating system 240 can be used in liquid cleaning system 100b of FIG. 1B. For example, gas generating system 240 can replace gas generating system 140 of FIG.

14

1B. Gas generating system 240 includes liquid region 107 and gaseous region 106, which are described in more detail above.

In this embodiment, gas generating system 240 includes electrode assemblies 120a and 120b. Electrode assemblies 120a and 120b include electrode terminals 123a and 123b, respectively, as shown in FIG. 6A. Electrode assemblies 120a and 120b include electrodes 122a and 122b, respectively, which extend through gas region 106 and terminate in liquid region 107, as described in more detail above.

In this embodiment, gas generating system 240 includes a vessel lid 250 carried by a vessel 241. Electrode terminals 123a and 123b extend through vessel lid 250. Vessel 241 and vessel lid 250 can include many different materials. Vessel 241 and vessel lid 250 include a material that is resistant to the chemicals of the reactant liquid and reactant gas. There are many different types of materials that are resistant to the chemicals of the reactant liquid and reactant gas, such as a plastic. There are many different types of plastics available, such as polypropylene and polyvinyl chloride.

Vessel 241 can be of many different types. In this embodiment, vessel 241 includes a vessel body 242, which includes a vessel base 243 at one end and a vessel body opening 244 (FIG. 6B) at an opposed end. Vessel base 243 supports vessel body 242 in an upright position so that vessel body opening 244 faces upwardly. It should be noted that, in some embodiments, vessel base 243 and vessel body 242 are repeatedly moveable between coupled and uncoupled conditions. Vessel base 243 and vessel body 242 are shown in the coupled condition in FIG. 6B. In other embodiments, vessel base 243 and vessel body 242 are a single integral piece.

In this embodiment, vessel lid 250 includes a vessel lid base 251 and vessel lid dome 252. Vessel lid 250 is repeatedly moveable between positions engaged with and disengaged from vessel body 242, wherein vessel lid 250 is engaged with vessel body 242 in FIGS. 6A and 6B, and vessel lid 250 is disengaged from vessel body 242 in FIG. 6B. It should be noted that vessel lid 250 covers vessel body opening 244 when it is engaged with vessel body 242.

FIG. 6C is a top plan view of vessel lid 250. In this embodiment, vessel lid 250 includes a gas output port 253, which extends through vessel lid dome 252. Gas output port 253 is sized and shaped to receive a conduit, such as conduit 101 (FIG. 5A).

In the embodiments of FIGS. 6A and 6B, vessel lid 250 is engaged with vessel body 242 in response to coupling an inner periphery of vessel lid 250 with outwardly extending lips 247a and 247b. In this embodiment, outwardly extending lips 247a and 247b are included with vessel 241, and extend partially around vessel body 242, as shown in FIG. 6D, wherein FIG. 6D is a top plan view of vessel body 242. Outwardly extending lips 247a and 247b extend partially around vessel body 242 so that a seal is not formed between vessel lid 250 and vessel body 242. A seal is not formed between vessel lid 250 and vessel body 242 so that the reactant gas can vent therebetween vessel lid 250 and vessel body 242. In this way, gas generating system 240 does not need to have a gas vent, such as gas vent 154 of FIGS. 2A, 2B and 2C. It should be noted that vessel lid 250 can be held to vessel body 242 in many other ways. For example, vessel lid 250 can be engaged with threads of vessel body 242, wherein the threads extend annularly around vessel body 242.

In the embodiment of FIGS. 6A and 6B, vessel body 242 is a single integral piece of material. However, it should be noted that vessel body 242 includes vessel body sections 242a, 242b and 242c, wherein vessel body section 242a is positioned proximate to vessel base 243, vessel body section

15

242c is positioned proximate to vessel lid **250** and vessel body section **242b** is positioned between vessel body sections **242a** and **242c**.

In this embodiment, vessel body section **242a** includes outwardly extending lips **245a** and **245b**, vessel body section **242b** includes outwardly extending lips **246a** and **246b** and vessel body section **242c** includes outwardly extending lips **247a** and **247b**. Outwardly extending lips **245a** and **245b** are positioned away from vessel base **243** and proximate to vessel body portion **242b**. Outwardly extending lips **246a** and **246b** are positioned away from outwardly extending lips **245a** and **245b** and proximate to vessel body portion **242c**. Outwardly extending lips **247a** and **247b** are positioned away from outwardly extending lips **246a** and **246b** and proximate to vessel lid **250**.

The size of gas generating system **240** is adjustable in response to adjusting the size of vessel body **242**. The size of vessel body **242** can be adjusted in many different ways. In one embodiment, vessel body **242** can be cut through a cut-line B-B (FIG. 6A) to form a gas generating system **200a**, which includes vessel body sections **242a** and **242b**, as shown in FIG. 6E. In this embodiment, vessel lid **250** is engaged with vessel body section **242b** in response to coupling the inner periphery of vessel lid **250** with outwardly extending lips **246a** and **246b**. It should be noted that gas generating system **200a** does not include vessel body section **242c** because it has been removed from vessel body section **242b**.

In another embodiment, vessel body **242** can be cut through a cut-line A-A (FIG. 6A) to form a gas generating system **200b**, which includes vessel body section **242a**, as shown in FIG. 6F. In this embodiment, vessel lid **250** is engaged with vessel body section **242a** in response to coupling the inner periphery of vessel lid **250** with outwardly extending lips **245a** and **245b**. It should be noted that gas generating system **200b** does not include vessel body sections **242b** and **242c** because they have been removed from vessel body section **242b**. Vessel body sections **242b** and **242c** are typically removed from vessel body section **242a** as a single integral piece.

It is useful to be able to adjust the size of gas generating system **240** because the desired size of gas generating system **240** depends on the amount of the fluid it is desired to treat. The desired size of gas generating system **240** increases and decreases as the amount of the fluid it is desired to treat increases and decreases, respectively. In one particular embodiment, gas generating system **240** holds about six gallons of reactant liquid in liquid region **107**, gas generating system **240a** holds about four gallons of reactant liquid in liquid region **107** and gas generating system **240b** holds about two gallons of reactant liquid in liquid region **107**. It should be noted that gas generating systems **240**, **240a** and **240b** can hold other amounts of reactant liquid in liquid region **107**, and six gallons, four gallons and two gallons is chosen for illustrative purposes.

It is useful to be able to adjust the size of gas generating system **240** by removing vessel body sections **242b** and/or **242c** so that a single mold can be used to form gas generating system **240**. The ability to use a single mold to form gas generating system **240** is useful because it reduces manufacturing costs.

FIGS. 7A and 7B are side views of another embodiment of a gas generating system, which is denoted as gas generating system **340**. Gas generating system **340** can be used in liquid cleaning system **100b** of FIG. 1B. For example, gas generating system **340** can replace gas generating system **140** of FIG. 1B. Gas generating system **340** includes liquid region **107** and gaseous region **106**, which are described in more detail above.

16

In this embodiment, gas generating system **340** includes electrode assemblies **120a** and **120b**. Electrode assemblies **320a** and **320b** include electrode terminals **123a** and **123b**, respectively, as shown in FIG. 7B. Electrode assemblies **320a** and **320b** include electrodes **122a** and **122b**, respectively, which extend through gas region **106** and terminate in liquid region **107**, as described in more detail above.

In this embodiment, gas generating system **340** includes a vessel lid **346** carried by a vessel connector **344**, wherein the vessel connector **344** is coupled to vessel **342**. Electrode terminals **123a** and **123b** extend beyond the vessel **342** into vessel connector **344**. Wires having terminal connectors (not shown) are coupled to the electrode terminals **123a** and **123b**. Vessel **342**, vessel connector **344** and vessel lid **346** can include many different materials. Vessel **342**, vessel connector **344** and vessel lid **346** include a material that is resistant to the chemicals of the reactant liquid and reactant gas. There are many different types of materials that are resistant to the chemicals of the reactant liquid and reactant gas, such as a plastic. There are many different types of plastics available, such as polypropylene and polyvinyl chloride.

Vessel **342** can be of many different types. For example, as shown the vessel **342** and the vessel connector **344** are shown as separate components, and in particular embodiments, the vessel **342** and the vessel connector **344** may be integral.

In this embodiment, vessel lid **346** is repeatably moveable between positions engaged with and disengaged from vessel connector **344**, wherein in the engaged position, as shown in FIG. 7B, the gas generation system **340** is in a condition to operate and in the disengaged position, the gas generation system, **340** is in a condition to access inner components, such as, but not limited to the electrodes **122a** and **122b**.

In this embodiment, vessel lid **346** includes a gas output port **348**, which extends into vessel lid dome **352**. Gas output port **348** may also include an adapter that is sized and shaped to receive a conduit, such as conduit **101** (FIG. 5A), such that gas flows through the gas output port **348**, through the adapter and into the conduit **101**.

In this embodiment, electrode assembly **320a** includes automatic adjusting electrode **122a**, which extends through an electrode housing **330a** such that an end of the electrode **122a** contacts a screen **343** coupled to an end of vessel **342**. The screen **343** is located on a bottom of the vessel **342**, wherein gravity draws the electrode **122a** into contact with the screen **343**. The vessel body **342** comprises an inner annular ring **345**, wherein the inner annular ring **345** functions to support the electrode housing **360a**, to maintain a bottom of the electrode housing a distance H1 from the screen **343**. This allows for a predetermined length of electrode **122a** to extend from the bottom of the housing **330a**.

Further, housing **330a** may include drain aperture **334a**, wherein the aperture **334a** allows for unused gas to escape through aperture **334a** in order to ensure that newly produced gas is utilized within the gas generating system **340**. Additionally, the aperture **334a** is small enough to inhibit an electrical connection with electrode **122b**.

Further in this embodiment, electrode assembly **320b** includes automatic adjusting electrode **122b**, which extends through an electrode housing **330b** such that an end of the electrode **122b** contacts a screen **343** coupled to an end of vessel **342**. The screen **343** is located on a bottom of the vessel **342**, wherein gravity draws the electrode **122b** into contact with the screen **343**. The vessel body **342** comprises an inner annular ring **345**, wherein the inner annular ring **345** functions to support the electrode housing **360b**, to maintain a bottom of the electrode housing a distance H1 from the screen

17

343. This allows for a predetermined length of electrode 122b to extend from the bottom of the housing 330b.

Further, housing 330a may include drain aperture 334b, wherein the aperture 334b allows for unused gas to escape through aperture 334b in order to ensure that newly produced gas is utilized within the gas generating system 340. Additionally, the aperture 334b is small enough to inhibit an electrical connection with electrode 122a. Further, vessel 342 may also include a drain aperture 347, wherein the old unused gas can escape from the vessel.

In operation, the electrodes 122a and 122b operate as described in detail above. During gas generation, the electrodes 122a and 122b wear or erode on the ends contacting the screen 343. As it wears away, gravity continues to draw the electrodes 122a and 122b to contact the screen, thereby always ensuring that an end of the electrodes 122a and 122b extend into the fluid region. The electrodes 122a and 122b are not restricted in vertical movement within the housings 330a and 330b respectively. Accordingly, as gravitation acts on the electrodes 122a and 122b, the electrodes move vertically down until the bottom of the electrodes 122a and 122b contact the screen. In at least this way, the electrodes 122a and 122b are automatically adjusting electrodes.

In another embodiment shown in FIGS. 8A-8D, a gas generation system 440 is shown. Gas generating system 440 can be used in liquid cleaning system 100b of FIG. 1B. For example, gas generating system 440 can replace gas generating system 140 of FIG. 1B. Gas generating system 440 includes liquid region 107 and gaseous region 106, which are described in more detail above. Further, gas generation system 440 comprises vessel 442 and end cap 446, wherein the vessel 442 includes a reservoir 444 within the vessel 442. The end cap is configured to attach to an electrode cartridge 420, wherein the electrode cartridge extends through the gaseous zone 106 into the liquid zone 107. Further, the vessel 442 is carried by base 352.

The electrode cartridge 420 comprises an electrode housing 430 with a screen 432 located on a bottom portion and a cap 460 coupled to a top portion of the cartridge housing 430. Electrodes 122a and 122b are held within the cartridge housing 430. The cartridge housing 430 comprises inner compartments 434, wherein the inner compartments 434 separate and isolate the electrodes 122a and 122b, except for the portion extending beyond the compartment 434 and in contact with the screen 432. The electrodes 122a and 122b are automatically adjusting electrodes as described with respect to FIGS. 7A-7B.

The cap 460 further comprises a gas output port 462, that is adapted to couple to a conduit 101 (FIG. 5A), such that gas flows through the gas output port 348, through the adapter and into the conduit 101. Further the cap 460 comprises electrical connector 450, wherein the electrical connector 450 is in electrical contact with electrode terminals 123a and 123b, wherein the electrical connector 450 contacts a contact point within the end cap 446 of the gas generating system wherein in this contact connects the electrode terminals 123a and 123b to a power source through power cable 470.

The electrode cartridge 420 is a repeatably replacement cartridge, wherein as the electrodes 122a and 122b wear, they ultimately stop working when there is no longer an ability to establish potential difference between the electrodes. A user may then easily replace the electrode cartridge 420 in order for the gas generating system 440 to operate again.

Embodiments of the present invention, as shown in FIGS. 7A-8D, counter the natural occurrence of raising the pH in freshwater that is in a confined space. The turning of the earth contributes in driving up pH levels in freshwater that is in a

18

confined space. Alkalinity is affected either up or down by base material or acidic material added to water that is in a confined space. Embodiments of the present invention triggers the effect of the scale of alkalinity up or down in order to keep it steady with in 60 ppm and 100 ppm, while balancing the pH within a range of 7.2 to 7.8. With the pH in this normal range the ions that are introduced into the water attaches to oxygen ion and do not destroy alkalinity, does not produce an odor, and reduces other side effects of water that is treated.

The embodiments of the invention described herein are exemplary and numerous modifications, variations and rearrangements can be readily envisioned to achieve substantially equivalent results, all of which are intended to be embraced within the spirit and scope of the invention as defined in the appended claims.

The invention claimed is:

1. A pool cleaning system, comprising:

a gas generating system, having a vessel body and first and second electrode assemblies operatively retained within the vessel body, wherein a reactant gas is formed in response to establishing a potential difference between the first and second electrode assemblies, and wherein the first and second electrode assemblies each comprise: an electrode housing; and an automatic adjusting electrode moveable within the electrode housing, wherein the automatic adjusting electrodes adjust in response to wear of the electrode during forming of the reactant gas; and a pool filter in fluid communication with the gas generating system, wherein the reactant gas is introduced into the pool filter.

2. The system of claim 1, wherein the pool filter includes a filtering material, and the reactant gas flows to the filtering material.

3. The system of claim 1, wherein the reactant gas flows to the pool filter through a pool pump.

4. The system of claim 3, wherein the gas generating system is in fluid communication with the pool filter through a strainer drain of the pool pump.

5. The system of claim 1, wherein the first and second electrode assemblies extend through a gaseous region.

6. The system of claim 5, wherein the distal ends of the first and second electrode assemblies are positioned in a liquid region.

7. The system of claim 6, wherein as the distal ends the first and second electrodes wear in response to forming of the reactant gas, the first and second electrodes automatically adjust down in position within the liquid region.

8. The system of claim 7, wherein the automatic adjustment of the first and second electrodes comprises gravitational force operating to draw the first and second electrodes down in position within the liquid region.

9. A pool cleaning system, comprising:

a pool pump; a gas generating system, having a vessel body and first and second electrode assemblies operatively retained within the vessel body, wherein a reactant gas is formed in response to establishing a potential difference between the first and second electrode assemblies, and wherein the first and second electrode assemblies each comprise: an electrode housing; and an automatic adjusting electrode moveable within the electrode housing, wherein the automatic adjusting electrodes adjust in response to wear of the electrode during forming of the reactant gas; and

19

a pool filter in fluid communication with the pool pump, wherein the reactant gas flows to the pool filter through the pool pump.

10. The system of claim 7, wherein the pool filter includes a filtering material, and the metal ion flows to the filtering material. 5

11. The system of claim 7, wherein the pool pump includes a strainer drain, and the reactant gas flows through the strainer drain.

12. The system of claim 7, wherein the gas generating system includes a liquid region which includes an acid. 10

13. The system of claim 10, wherein the distal ends of the first and second electrode assemblies are positioned in the acid.

14. The system of claim 13, wherein the electrode includes an electrode terminal connected to an electrode body. 15

15. The system of claim 14, wherein as the distal ends the first and second electrodes wear in response to forming of the reactant gas, the first and second electrodes automatically adjust down in position within the liquid region.

16. The system of claim 15, wherein the automatic adjustment of the first and second electrodes comprises gravitational force operating to draw the first and second electrodes down in position within the liquid region. 20

17. A cartridge for use in a pool cleaning system, the cartridge comprising:

20

an cartridge housing having a first inner compartment and a second inner compartment;

first and second automatically adjusting electrodes moveably retained within the first and second inner compartments, wherein the first and second inner compartments separate and isolate the first and second electrodes; and a screen coupled to bottom end of the cartridge housing, wherein distal ends of the first and second electrodes extending beyond the first and second compartments and in contact with the screen.

18. The cartridge of claim 17, a cap coupled to a top end of the cartridge housing, the cap comprising a gas output port and an electrical connector.

19. The cartridge of claim 18, wherein the electrical connector is in electrical contact with first and second electrode terminals of the first and second electrodes, wherein the electrical connector connects the first and second electrode terminals to a power source.

20. The cartridge of claim 19, wherein as the distal ends the first and second electrodes wear in response to forming of a reactant gas when the cartridge is used in a gas generating system, the first and second electrodes automatically adjust down in position within a liquid region of the gas generating system.

* * * * *